Project no. TIP5-CT-2006-031415

INNOTRACK

Integrated Project (IP)

Thematic Priority 6: Sustainable Development, Global Change and Ecosystems

D5.4.1 – First Report on the Logistics of S&C

Due date of deliverable: 2009-05-31

Actual submission date: 2009-11-06

Start date of project: 1 September 2006 Duration: 36 months

Organisation name of lead contractor for this deliverable: Network Rail

Revision [final]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
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Table of Contents

Glossary

Abbreviation/acronym	Description
BV	Banverket
CSS	Corus Steel Slab
IM	Infrastructure Maintainer
KPI	Key performance indicators
LCC	Life cycle costs
MTBSAF	Mean time between service affecting failures
M&R	Maintenance and renewal
NR	Network Rail
PICOP	Staff member with designated competency: “Person in charge of possession”
NR60	Network Rail specification for 60kg/m Vignoles rail
S&C	Switch(es) and Crossing(s)
SNCF	Société Nationale des Chemins de fer Français

1. Executive Summary

The present deliverable gives a first report on the logistics of S&C including solutions developed within the SP3 Switches & Crossings.

It will be completed by a final report which will go deeper into the details of the logistics of S&C.

The overall objective of the work, from a track construction point of view, is to improve the installation time of each innovative solution and thus provide an additional lever in LCC reduction.

This report details the methodology undertaken, the results, and concludes by recommending strategies for S&C renewal logistics that will contribute to the goal of reducing LCC by 30%.

The methodology followed can be summarised by the four phases detailed below:

1. Review of current practice by European IMs for S&C maintenance and renewal logistics, with identification of best practice and logistics work volume baselining;
2. Determination of logistics requirements for novel S&C renewal and predictive S&C maintenance methodologies including consideration of outputs from INNOTRACK SP3;
3. Comparison of logistics work volumes for novel S&C maintenance and renewal solutions with baseline (i.e. conventional maintenance and renewals);
4. Production of recommendations for optimisation of S&C logistics strategy to minimise costs of installation, whilst maintaining the quality of installation both initially and in terms of subsequent deterioration under traffic.

The results of the review of the S&C current renewals and maintenance practice by European IMs are based on the findings from IM questionnaire programme undertaken as part of INNOTRACK Work Package 5.1 combined with more detailed studies of Banverket, Network Rail and Deutsche Bahn S&C maintenance and renewal practices, including the logistics required to support these.

The subject of novel S&C methodologies and associated logistics requirements is tackled with input from SP3 Switches & Crossings, discussion of the potential benefits of adopting modular S&C technologies, and the use of pre-assembled slab S&C technologies such as Corus Steel Slab.

Finally a summary of anticipated future logistics requirements from adoption of novel technologies is provided. This section covers the discussion of how delivery of S&C using the new methodologies recommended by SP3 and the other new technologies would impact on S&C logistics requirements, i.e.:

- Potential for improvement in the initial quality of installation, and the subsequent benefits from reduction in track geometry and component degradation.
- Potential for reduction of life cycle costs.
- Potential manpower savings.
- Potential for reduction in possession times.
- Potential for restoration of immediate full linespeeds.
- Potential for modal shift from road to rail (or vice versa) for delivery of components and S&C units.
- Shortening of delivery timescales.

2. Introduction

The purpose of INNOTRACK work package 5.4 has been to develop switch and crossing (S&C) construction and logistics methods for several innovative solutions that have been identified by work package (WP) 5.1 and sub-project (SP) 3 in coordination with the related SP/WP teams. These methods have been developed in order to improve installation rate, quality of installation and to reduce the subsequent need for maintenance, thereby contributing to LCC reduction. Each step of the installation process has been analysed and particular focus has been put on the supply chain from production point to final installation point in order to identify possibilities to achieve higher quality and for optimisation and simplification.

In addition, maintenance aspects will be addressed in close cooperation with the SP3 team. This includes an analysis of the frequency of needed maintenance operations and development of M&R methods. The feasibility of predictive maintenance based on pre-determined parameters have been assessed. It is a known fact that quality of installation has a big impact on LCC.

The overall objective of the work, from a track construction point of view, is to improve the installation quality and reduce the installation time by employing the appropriate innovative solution and thus provide an additional lever in LCC reduction.

This report details the methodology undertaken, the results, and concludes by recommending strategies for S&C renewal logistics that will contribute to the goal of reducing LCC by 30%.

It is a first report and it will be completed by a final report which will go deeper into the details of the logistics of S&C.

3. Method

This work package was undertaken in four phases:

1. Review of current practice by European IMs for S&C maintenance and renewal logistics, with identification of best practice and logistics work volume baselining;
2. Determination of logistics requirements for novel S&C renewal and predictive S&C maintenance methodologies including consideration of outputs from INNOTRACK SP3;
3. Comparison of logistics work volumes for novel S&C maintenance and renewal solutions with baseline (i.e. conventional maintenance and renewals);
4. Production of recommendations for optimisation of S&C logistics strategy to minimise costs of installation, whilst maintaining the quality of installation both initially and in terms of subsequent deterioration under traffic.

More detail on the specific methodology followed for each of these phases is given in the following sub-sections.

3.1 Current practice for S&C maintenance and renewal logistics

This work activity involved a review of previous work undertaken within the INNOTRACK project, most notably SP3 – Switches & Crossings, and the earlier work undertaken within this sub project under WP5.1. Further information was also acquired through direct communication with IM representatives involved in the INNOTRACK project via email communication and through SP3 and SP5 project meetings.

The IMs involved in this work package then discussed and agreed a set of current best practice strategies for S&C logistics for subsequent comparison against the logistics strategies identified for the novel S&C technologies.

3.2 Determination of logistics requirements for novel S&C renewal and preventative maintenance methodologies

This work activity involved determination of the logistics requirements that would be needed to deliver the novel S&C renewal and predictive maintenance technologies identified by INNOTRACK Sub Project 3 – Switches & Crossings, more specifically, the work activities and volumes that would need to be undertaken. This was achieved through collaboration with the SP3 participants via SP meetings backed up with direct communication with IM representatives involved in the INNOTRACK project. Additional data used for this work activity also came from three major sources, these being:

- Results from the IM questionnaire programme undertaken as part of INNOTRACK Work Package 5.1;
- Results from SP3 detailed in report D3.1.1;
- More detailed information obtained from a number of IMs through direct discussions.

In addition to the novel S&C technologies identified under SP3, two other potential novel S&C technologies were considered included modular S&C technologies (the use of which is increasing throughout Europe) and the use of a pre-assembled S&C unit mounted to a slab.

Where it was found that a number of potential options existed for logistics strategies for any particular novel S&C technology, the pros and cons of each were determined. Options for simplifying S&C logistics were identified where possible, including quantification of any potential savings that may be accrued.

3.3 Comparison of logistics work volumes for novel S&C maintenance and renewal solutions with baseline

Having determined the logistics requirements associated with the novel S&C technologies, this work activity undertook direct comparisons between them and the baselined current best practice S&C logistics requirements. This enabled changes in the logistics activities and work volumes, and hence costs, that would be expected to occur through implementation of novel S&C technology.

3.4 Production of recommendations for optimisation of S&C logistics strategy for optimised reduction of costs

This work activity will involve the consolidation of the outputs from the research undertaken under this work package and produce recommendations for development of optimised S&C renewal and maintenance strategies for routes of the types considered where possible through quantification of the potential contributions to LCC savings. This will be achieved through LCC analysis in conjunction with the work being undertaken within SP6, and will be detailed in a subsequent version of this report.

4. Results

This section details the findings from the work activities undertaken that were defined in Section 3.

4.1 Review of current practice for S&C maintenance and renewal, and associated logistics

For S&C renewals, the results from the IM questionnaire programme undertaken as part of INNOTRACK Work Package 5.1 stated that:

- All IMs use framework contracts for the supply of S+C. Contract duration varies from one to five years and the contracts do not carry volume guarantees
- S+C for renewals is generally ordered between six and twelve months in advance.
- S+C for maintenance is generally ordered between three and six months in advance
- IMs use on average two S+C suppliers
- S+C is not held in stock by IMs
- 95% of S+C for renewals is distributed by rail
- Less than 15% of S+C renewal is of the modular type. 70% is assembled by the side of the line, while a further 15% is renewed piecemeal

For S&C maintenance activities post-renewal, the results from SP3 detailed in report D3.1.1 concluded that for a typical mixed traffic railway, the main cost drivers (without inspection/service/test) are:

- Short-range planned actions after inspections with 30%. This is mainly adjustment, build up welding and minimal repairs. These are actions after inspection but are seen by Banverket as immediate corrective maintenance.
- Long-range planned actions after inspection with 26%. This includes replacement of frogs, switch rails and check rails. This is part of the condition based maintenance.
- Costs for inspections & predetermined maintenance are 17%.

The costs for these measures sum up to 73% while the amount for the other activities inspection, grinding and tamping are of 27%.

Additionally, the work concluded that whilst maintenance costs do not differ greatly between types of S&C, the type of track in which the S&C is installed does have a significant influence on maintenance costs, i.e.:

- The maintenance costs per unit for S&C types UIC60-300 and UIC60-760 on main track are about the same.
- The maintenance costs on main track are about 7.8 times higher than on slow/relief track.

Additional information on S&C renewal practice and logistics requirements relevant to delivery of this work package was obtained from a number of IMs through discussions, and this is summarised in the following sections.

4.1.1 Network Rail practice

The majority of S&C units and half-sets currently used in renewals on Network Rail infrastructure are manufactured off-site and then assembled for quality purposes at the site of manufacture, prior to dismantling and re-assembly on site. Transport of S&C components to site is undertaken by rail or

road broadly in line with the WP5.1 proportions. Conventional S&C renewal usually requires large areas adjacent to the renewal site for assembly of S&C, which, if the land is not owned by the IM, can inconvenience the landowners and introduce the need for the IM to negotiate with them to gain access to and use the land.

The work activities undertaken to plan and undertake S&C renewals vary according to the speed and type of switch, and the geographical location, however the following list summarises the major work activities for typical S&C renewals generally in the order in which they are undertaken:

- Planning activities – identification of S&C renewals requirements, possession availability, access points, followed by sourcing of materials, plant, staff, and logistics. Plans are produced two years in advance of the renewals taking place as part of the Rules of the Plan process.
- Sourcing of components from suppliers. This includes the manufacture of the S&C units at the suppliers' own factories, assembly for quality control assessment, and disassembly for storage prior to the renewals taking place.
- Pre-renewal preparation – transport of small components (ballast, sand, fastenings etc) and plant (lighting, generators etc.) to a convenient site close to the renewals site.
- On-site S&C renewal:
    - Site safety staff provision – PICOP, Site Wardens, Lookouts.
    - Labour provision – surveyors, track engineers, signalling engineers, welders, labourers.
    - Plant requirements – excavators, road transport and crane plus crews.
    - Transport to site – components and ballast (existing ballast is always replaced as part of S&C renewal irrespective of condition as defined in company standards).
    - Dismantling of existing life expired S&C requires removal of components, ballast and other spoil.
    - Site assembly – Following complete renewal of ballast, the S&C is assembled on site with as much welding as is possible within the time constraints (minimum requirements are defined in company standards), otherwise joints are clamped.
    - Track geometry restoration.
    - Commissioning and checking of the interfaces with signalling.
    - Final inspection and acceptance by permanent way engineer.
- Handback to traffic and imposition of temporary speed restriction (usually 80km/h for 14 days for conventional renewal).
- Geometry checking and maintenance following period of temporary speed restriction, with welding to replace clamped joints where necessary.

The Schedule 4 penalty payments payable by Network Rail resulting from the need to impose line closures for S&C renewal are a major part of total Schedule 4 penalties: for example, in 2008/9 26% of the total compensation resulted from the renewal of 400 units, however, it must be noted that some penalties may have been caused by other activities piggy-backing on the renewals. The current possession requirements for conventional renewal of a typical crossover are typically 37 hours, which in recent years has been reduced from 54 hours under KPI-driven improvement gains in installation of conventional S&C. These gains have come from early deployment of the principles of the Modular S&C renewal concept being implemented by Network Rail, which has optimised the process by taking contingency out and introducing automated ballast collection for NR60 S&C layout renewals. These and the other benefits that Network Rail anticipates to gain from implementation of modular S&C renewals are detailed in Section 4.2.2.

4.1.2 Deutsche Bahn practice

DB Netz (infrastructure) replaces around 1,500 S&C units per year, which are supplied by the one factory that it owns, and two other factories in Germany producing S&C. The latter two factories supply nearly 75 % of all switches for DB Netz, and more if demand exceeds the capacity of its own factory

DB Netz (infrastructure) uses three methods for renewals or new building of switches:

- preassembled at the site (90 %)
- assembling in situ (9%)
- preassembled at the factory (< 1%)

The decision how S&C is to be installed depends on economical aspects, and there are no major differences between S&C renewals on high-speed lines and conventional lines. Normally the most economical way is the assembling at the site. Access is normally achieved using trackside access roads which minimises the need for negotiations to gain access via neighbouring landowners' property.

In most cases switches are assembled at the site, with the components carried as far as possible by road vehicles, otherwise by train.

The time which is needed for changing a standard switch (UIC60-EW-500-1:12) takes about 8 hours, which is broken down into the following tasks:

- removing the old switch
- removing the old ballast
- bringing in new ballast – typically new ballast is used to improve track geometry
- assembling the new switch (segments)

Additional time is needed for:

- interfacing the switch with signalling and control equipment
- ballast tamping to restore track geometry
- measuring (acceptance tests)

Typically, pre- and post-possession activities require 5 – 10 hours, depending on the renewal.

In most cases, nearly 99%, DB Netz uses heavy cranes (load up to 40 tons) to fit the preassembled segments of the switch into the track. There are also other methods of installing the segments into the track such as the UWG relaying system for turnouts and track panels, and use of vehicles such as 2-way diggers, road cranes and the Italian VAIA-Car.

In most cases the switches are clamped during installation and the welding is completed before the line is reopened, which is usually at linespeed as long as the ballast has been tamped to restore the track geometry.

In the longer term, DB Netz has aspirations to implement "plug and play" techniques to speed up replacement and commissioning of components interfaced with the signalling system (e.g. point motors) using computerised self testing, and is drawing up a strategy to fulfil these aspirations.

4.1.3 Banverket practice

Banverket makes extensive use of pre-assembled S&C in its renewal projects (about 40 per year), and currently S&C renewals take about 30 hours, including the time needed to recommission the signalling. Pre- and post-possession activities (e.g. transport of other materials and plant to/from site) in total take about one week, depending on the needs of the individual project. In terms of differences

between S&C renewals on high speed lines and those on conventional lines, the activities are the same, however different track closure times apply.

Typically, trackside access is via trackside access roads which minimises the need for negotiations to gain access via neighbouring landowners' property.

Ballast is always replaced during S&C renewal, and the welding resource needed is 2 workers for 2-3 days depending on track closing times.

On reopening to traffic following switch replacement, the line is reopened at linespeed or 70 km/h, whichever is the lowest.

Banverket is developing and marketing "plug and play" techniques to speed up replacement and commissioning of components that are interfaced with the signalling system (e.g. point motors) using computerised self testing.

4.1.4 Current best practice baseline

For S&C renewals, the specific information given by Banverket, DB and Network Rail regarding the renewal techniques used shows that proportions are broadly in line with those established by work package 5.1, namely:

- <15% of S+C renewal is of the modular type;
- 70% is assembled by the side of the line;
- 15% is renewed piecemeal.

Although IMs are using pre-assembled S&C to some extent, it is still not a widespread technique, and can be considered to be an emerging technology. It will therefore be assessed further as a novel S&C renewal technique in Section 4.2.

Taking the remaining two S&C renewal techniques, it is clear that assembly of the S&C adjacent to the worksite must be taken as being best practice, given that 70% of renewals are of this type. There are also a number of fundamental advantages that this technique has over the policy of piecemeal S&C renewal, these being:

- On acceptance of the S&C at the factory, disassembly, transport and reassembly near the renewal site is relatively straightforward;
- S&C can be constructed near to the worksite and installed with minimised disturbance to traffic;
- The quality of the components and installed geometry is known to be good upon commissioning, unlike piecemeal renewals which can result in S&C units with components of varying age and condition.

The novel S&C renewal techniques, and resulting maintenance requirements, will therefore be baselined against the practice of assembling S&C on the lineside before installation.

4.2 Novel S&C renewal and maintenance methodologies and associated logistics requirements

This section details the novel S&C methodologies identified through discussion with the IMs participating in the work package, and potential technologies that have emerged from the knowledge gained from WPs 3.1 and 5.1. A description of each technology is given along with a description of the specific logistics requirements needed for the renewal and maintenance of each.

4.2.1 Inputs from Sub-project 3 – Switches and Crossings

At the time of issue of this report, the majority of the outputs from SP3 have been relate to the novel design of S&C components, such as frog and backdrive design and switch rail and frog geometry, rather than novel S&C systems or layouts as a whole. It is considered likely that the S&C systems that do ultimately emerge as outputs from SP3 will not, however, require a radically different installation technique to the current designs, with the exception of the pre-assembled slab S&C technology.

This report therefore considers only renewal of S&C via the modular technique, and the use of S&C the pre-assembled slab S&C technology.

4.2.2 Modular S&C technologies

A number of IMs have already introduced the modular concept for renewal of S&C, whereby the S&C units are assembled at the factory as the whole unit, or in 2 or 3 large parts, and then transported to the renewals site using specialised railway wagons. The S&C units are then lifted into position as complete assemblies, thus maintaining the geometric quality of the S&C once installed. The modular S&C concept also offers considerable savings in terms of the possession time needed (and hence costs from performance penalties incurred through network lack of availability) and resource, although specialist plant needs to be constructed. IMs that have introduced modular S&C renewal include DB, SNCF, Banverket and Infrabel, whilst Network Rail is at an advanced stage in introducing the technology at the time of writing. Opinions were sought from these IMs as to the actual and aspirational benefits associated with the logistics for modular S&C renewals, and these are summarised in the following sub-sections.

Deutsche Bahn

As stated in Section 4.1.2, DB S&C renewals that use the modular concept are currently less than 1% of the total. S&C preassembled at the factory used is only used for special locations, for instance:

- S&C renewals in tunnels or on embankments
- there are space constraints for S&C assembly at the site
- assembling in situ is considered to be too expensive

S&C preassembled at the factory are transported by special rail vehicles. DB Netz is the owner of 8 special vehicles, known as Weichentransportwagen (WTW).

Banverket

Banverket makes extensive use of pre-assembled S&C in its renewal projects (about 40 per year); please refer to Section 4.1.3 for more information.

Network Rail

Network Rail is currently developing a strategy to introduce renewal of S&C using concrete bearers and modular delivery and installation, which is being implemented in two phases initially. By April 2014, Network Rail expects to be delivering three-quarters of the track renewals work bank using the modular concept, which corresponds to an estimated 270 units of S&C renewed per annum (i.e.: 75%

of 340), although this will inevitably vary according to S&C renewal policy that is being practised at that time.

The rollout of the first phase of the modular S&C renewal concept will apply the KPI-driven improvement gains already applied to the installation of conventional S&C to achieve crossover (not turnout) renewal in 37 hours. The aspiration for the second phase is to achieve this in 4 x 8 hour possessions over a weekend or mid week, or 21 hours in one weekend possession. This time includes the time needed to recommission the signalling, but does not include the follow-up work such as tamping and stressing. The differences in the work activities needed to deliver modular S&C renewal compared with those for conventional S&C renewal are as follows, with anticipated savings in time/cost noted where appropriate:

- Preparation: significant time and cost savings incurred through the need to assemble the S&C unit once only at the factory;
- Delivery: delivery of the S&C panel can be made directly from the factory to site in one train operation;
- Commissioning: installation of the S&C panel in one piece ensures that the geometry and quality installed in the controlled environment of the factory are maintained as far as possible, resulting in time and cost savings from not having to fettle the S&C panel once installed;
- Maintenance of post-installation quality: as a result of the improved installation quality, the subsequent rate of deterioration of the S&C panel in terms of track geometry and component condition is reduced.

Delivery of S&C to site using the modular concept utilises tilting-bed wagons stationed in the appropriate position on the adjacent track, which eliminates the need for large areas needed adjacent to the renewal site for assembly of S&C. Benefits are also realised from minimising the potential inconvenience to adjacent landowners and the need to negotiate with them to gain access to the land. The modular S&C concept still requires some access to site for supporting road transport vehicles and plant, which where these exist, can utilise trackside access roads.

Pre-possession activities for modular S&C renewals are similar to those for conventional S&C renewals, and include the setting up of site lighting and the delivery of smaller consumables. The major pre-renewal work activity needed is to prepare for the use of an automated ballast collection system: cable troughing and other trackside fittings need to be cleared in the cutting envelope of the ballast collector prior to work commencing. It must be noted that the use of automated ballast collection is generic to the renewal of RT60 S&C layouts by whatever technique, rather than being specific to modular S&C renewals.

Ballast is always replaced during a switch renewal, as defined in company standards, and arrives on the night, in line with the just-in-time principle practised under the modular S&C renewal concept. This leaves little contingency to deal with emerging issues (such as the need for sand etc. that was not not planned for).

Welding resource required is as for normal S&C, but introduction of flash-butt welding will speed up the process. As many joints as can be achieved are welded during the renewal possession, with at least the minimum number mandated in the company standards welded. The remaining joints are clamped for welding at a later date.

On reopening to traffic following modular S&C renewal, the line will be reopened at 80kph, with the restriction remaining in place for 14 days as for conventional S&C renewals. Full implementation of modular S&C renewals is ultimately expected to result in improvements in the immediate post-installation track geometry quality significant enough to reduce application of the speed restriction to 5 days, which helps to reduce Schedule 4 train delay penalties as a result of the speed restriction. This increased immediate post-installation quality in turn will result in significant reductions in subsequent track geometry and component deterioration, and thus mean time between service affecting failures (MTBSAF) and component life.

The modular S&C renewal is fundamental to Network Rail's aspirations for implementation of "plug and play" techniques to speed up replacement and commissioning of components that are interfaced together and with other systems, for example point motors and signalling, using computerised self testing. Introduction of the plug-and-play concept is a key element in the evolution of modular S&C

renewal strategies, and the first application is scheduled to be undertaken in early 2010. Ultimately, it is hoped that a time of 30 minutes may be achievable for replacement and recommissioning of point motors. Another example of application of the plug-and-play concept will be assembly of location cabinets off-site with plug-and-play installation to speed commissioning.

The aspiration to significantly reduce costs and resources needed for S&C renewals are key to the modular S&C renewal concept, although some increase in plant capital costs will be needed given its complex and specialised nature. Target cost reductions are to reduce the unit rate for replacement of S&C by 11%, with other cost benefits to be accrued from longer operational life and reduced maintenance through increased installation quality, with the goal to increase the MTBSAF to 1 in 2.5 years initially, and 1 in 3.5 years ultimately. Reduced possession requirements will also give significant savings in Schedule 4 compensation payments through improving network availability and capacity; one 8 hour possession will result in an 80-90% reduction in Schedule 4 compensation when compared with the baseline of 54 hours.

4.2.3 Use of pre-assembled slab S&C technologies

a) Summary of logistics aspects of Corus Steel Slab (CSS) based S&C

Installation/Renewal

The advantages of pre-assembled S&C on slab is similar to the benefit from modular pre-assembled S&C on concrete bearers (see previous NR section), with the following differences:

1. The Corus slab system has a much lower net ballast/formation material requirement.

2. The structure has intrinsic strength and stiffness – it will obviously support its own weight, so that transportation does not require the same support to be built into the wagons.

3. The structure can be jointed using structurally sound connections and then assembled in position, thus allowing transportation within a smaller structure gauge.

Note that the system does not weigh less than a comparable concrete bearer system.

Maintenance

The main purpose of the CSS system is to reduce maintenance, in particular:

- Removal of the tamping requirement;
- Retention of track geometry within the S&C and optimised design of the resilience supporting the rail , resulting in less damage to components including the rail.

Evaluation of the logistics aspects of these will depend on information about current maintenance practice and costs on conventional S&C from the IM's (see elsewhere in this report?)

b) Development of information to quantify the logistics aspects.

Corus is currently undertaking a demonstration project on a sample of plain line, during which work study and materials flows will be recorded. This will form the basis for a model to be scaled up to a full S&C installation. The conclusions will be reported through the WP 2.3 final deliverables.

Information from relevant LCC analyses will also be channelled into the logistics evaluations.

4.3 Summary of anticipated future logistics requirements from adoption of novel technologies

For modular S&C renewals

The IMs who have adopted the modular S&C renewal technique have demonstrated that cost savings can be realised from the following:

- Potential for improvement in the initial quality of installation, and the subsequent benefits from reduction in track geometry and component degradation.

- Potential for reduction of life cycle costs.
- Potential manpower savings.
- Potential for reduction in possession times.
- Potential for restoration of immediate full linespeeds.
- Potential for modal shift from road to rail (or vice versa) for delivery of components and S&C units.
- Shortening of delivery timescales.

For CSS based S&C

- Potential for modal shift from road to rail (or vice versa) for delivery of components and S&C units.
    - All components will be deliverable by rail
- Implications on delivery timescales.
    - Pre-assembly and the use of CSS (compared with ballasted track requires a) an additional step in the supply chain, and b) additional materials. These will have to be planned into the scheduling. Manufacturing is relatively non-specialist so that this resource will not be a limiting factor. It is possible that the total number of journeys will reduce and inventory will be clearly visible before a possession, reducing the likelihood for delays
- Potential manpower savings.
    - For future evaluation, but believed to be comparable with modular S&C
- Potential for reduction in possession times.
    - This is one of the main drivers for the pre- assembled CSS “panel” approach, in common with the modular approach. Quantification will be reported after trials unlikely to be completed during the timescales of this project.
- Potential for restoration of immediate full linespeeds.
    - This is intrinsic in the design of the CSS pre-assembled panel.

4.4 Recommendations for optimisation of S&C logistics strategy for optimised reduction of costs

This work activity will involve the consolidation of the outputs from the research undertaken under this work package and produce recommendations for development of optimised S&C renewal and maintenance strategies for routes of the types considered where possible through quantification of the potential contributions to LCC savings. This will be achieved through LCC analysis in conjunction with the work being undertaken within SP6, and will be detailed in the final report to be issued once the necessary outputs needed for the analysis become available.

5. Conclusions

The present deliverable gives a first report on the logistics of S&C including solutions developed within the SP3 Switches & Crossings.

It will be completed by a final report which will go deeper into the details of the logistics of S&C and quantification of the contribution improved logistics practices can make LCC reduction.

The analysis to date has showed that implementation of a renewal strategy based on the use of either of the modular S&C technologies studied would have the potential to reduce S&C logistics costs through:

- Improvement in the initial quality of installation, and the subsequent benefits from reduction in track geometry and component degradation.
- Reduction of life cycle costs.
- Manpower savings.
- Reduction in possession times.
- Restoration of immediate full linespeeds.
- Modal shift from road to rail for delivery of components and S&C units.
- Shortening of delivery timescales.