Edinburgh Trams

For The Attention of Martin Foerder
Project Director
Bilfinger Berger Siemens CAF Consortium
9 Lochside Avenue
Edinburgh Park
Edinburgh EH12 9DJ

Our Ref: INF CORR 4635/RB

Date: 02nd April 2010

Dear Martin,

Edinburgh Tram Network – Infraco
Design Audits – Final Report

We refer you to the following audits carried out by tie under Clause 104 of the Infraco Contract with respect to:-

- Roads and drainage design for section 1D
- Structures – Bankhead Drive Retaining Wall
  Baird Drive Retaining Wall
  Depot Access Bridge
  A8 Underpass
- Track design and improvement layers
- OLE system and foundations

We enclose tie's final report detailing the matters audited and the findings of the audit team. This report is issued to you without prejudice to tie's position now or at a future date with regard to any of the matters referred to therein.

Please confirm your proposals with respect to the findings of the audit team.

[redacted]

Yours sincerely

[redacted]

Steven Bell
Project Director – Edinburgh Tram

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Design Audit

Audit under Clause 104 of the Infraco Contract

January/February 2010

tie Limited

Audit under Clause 104 of the Infraco Contract

Executive Summary

A requirement to carry out an audit of Changes and differences in Design was identified by tie in January 2010. The scope of the audit focussed on 4 particular areas:-

- Roads and Drainage design for section 1D
- Structures Baird Drive retaining wall
  Bankhead Drive retaining wall
  Depot Access Bridge
  A8 Underpass
- Track design and improvement layers
- OLE system and foundations

This report is issued to BSC without prejudice to tie's position now or at a future date with regard to any of the matters referred to therein. The report details the process, observations, and findings of the audit.

Each audit comprised core members from the audit team plus technical experts. Each team is identified within the subsection dealing with the specific audits.

A number of themes gave the audit team cause for concern:-

- Little evidence that Infraco have properly managed the design process in a timely manner.
- Lack of evidence that Infraco have paid serious attention to Best Value design solutions.
- The final outputs of design have produced solutions that appear to be in excess of the needs of the Client. (e.g. void spanning)
- No acceptance of liability for pre-novation Issues.
- Lack of engagement with the audit process.

Initially Infraco refused to co-operate fully with the audit team. After discussion with tie and having taken advice within Infraco this position changed early on in the audit. The Infraco response to the audit changed again later in the process. Citing legal advice, their response to certain audit questions was that "Provision of this information was not an obligation under Clause 104 the Infraco Contract". Infraco

were advised that tie disagree with their position on this matter and a further attempt was made at retrieving the information. This was unsuccessful and information requested for the audit remains outstanding from Infraco.

The audit team were not provided with the level of documentary evidence that would be expected in such circumstances leading the team to two conclusions:

- that not all documentation has been provided to them as required under the contract,
- that the expected level of management engagement evidenced through documentation that would be expected to exist on a contract of this nature does not exist.

The audit was based on a set of questions posed to Infraco by tie. Minutes were taken of the audit meetings and the evidence obtained was scheduled.

General Commentary

The main themes identified by the audit team with respect to Infraco's management of the areas audited were:

- Little evidence that Infraco have properly managed the design process.
- Lack of evidence to suggest that Infraco have paid serious attention to Best Value design solutions.
- The final outputs of design have produced solutions that appear to be in excess of the needs of the Client. (e.g. void spanning)
- No acceptance of liability for pre-novation Issues.
- Lack of engagement with the audit process.

These are discussed further below:-

Little evidence that Infraco have properly managed the design process.

Infraco are obliged to carry out all required management activities in order to manage the performance of the SDS Services in accordance with Clause 11 of the Infraco Contract and Clause 6.1 of the SDS Novation Agreement.

Despite substantive requests throughout the audit meetings, Infraco were unable to produce evidence of positively managing SDS in the areas within the scope of the audit. Infraco were unable to produce many letters, memos, emails, and minutes of meetings to substantially evidence this obligation. Searches of their BIW document archive system conducted by Colin Brady (Infraco Director of Engineering) failed to reveal the volume of supporting documentation expected, save for only two letters in which they press SDS for information relating to Trackform design. Further follow up meetings asking for any information or details of how Infraco have managed the design programme did not produce anything that demonstrates the discharge of this contractual obligation. Some information was subsequently uncovered by tie but not presented by Infraco as evidence.

Infraco advised that on occasion they did use priority lists to expedite design production for the design of the OLE bases and poles, however the only evidence was an e-mail advising Bob Bell (tie Construction Director) of certain Roads and Drainage priorities with respect to Scottish Water approvals. tie queried why his evidence had been presented as demonstration of Infraco prioritising OLE design programme, and were advised by Infraco that this documentation implied that the OLE design programme was being similarly prioritised. Given the amount of design required off street for OLE, this was not considered to be a credible explanation. There was nothing that clearly directed SDS to produce designs to a programme and manage their progress against such.

The prospect of an On Street Supplemental Agreement and the delay in achieving such was referred to as something that was preventing the Consortium from delivering against its current obligations.

Infraco have taken a position over their engagement with managing the design programme by referring to the ongoing delays with reference to MUDFA issues as the overarching reasons not to be putting energy into completing the process.

Output from design Development Workshops (established to address mis-alignment issues) has taken considerable time to be developed - e.g. with respect to road design, the Highways Standards Appendix 7.1, tie's independent engineers (AECOM) considered an appropriate work content of approximately two months but SDS took over a year to bring it to its current revision. This document now stands at Revision 6, with a further revision outstanding. Even assuming this number of revisions was required; this could have been produced in a period of 12 to 16 weeks.

There was no evidence (from responses to questions or documentary) that Infraco has put any pressure on SDS or has used, or threatened to use any of the contractual mechanisms available to it, in particular the exercise of the Liquidated Damages which are contained in the SDS Agreement, as amended by the SDS Novation Agreement (Clause 27.7). At the Trackform further follow up, Infraco confirmed that it had not used any sanctions against SDS and was satisfied that SDS had carried out the work they were meant to in accordance with the relevant Change Order. The audit party gave Infraco a number of opportunities to confirm if there is other documentation or correspondence which demonstrates that it has managed the design process, to which the response was always negative.

For example: Some of the questions Bob Bell asked in the roads audit follow up on Tuesday 2nd February include:

RB: "Can you demonstrate that the programme introduced at V45 was agreed with SDS or that you instructed SDS to work to this programme?".

CB: "No, other than accepting the programme. There is no correspondence".

.....

CB: "tie's hypothesis is that Infraco failed in managing the programme. Are there records of the management of this particular process? I think there aren't".

.....

RB; "Is there anything else regarding programme management which we're not aware of, that Infraco would want to put up as demonstration of this?".

CB: There is no regular class of correspondence that you're not aware of".

.....

Note: At the time of writing this report it has become apparent that Infraco advised in another audit, carried out by Nichols Group on behalf of tie, that they had implemented a "Focus and Prioritisation" process with respect to their design programme. Further details were sought from Infraco in this respect at final follow up meetings. Infraco advised that the "Focus & Prioritisation" flowchart had been developed to illustrate to the Nichols audit team how it managed this process but that

it had not been formally introduced as a project procedure and no separate evidence was available to demonstrate this process was actually implemented.

Lack of evidence to suggest that Infraco have paid serious attention to Best Value design solutions

Infraco has contractual obligations in relation to providing Best Value for the Infraco Works. *(Clause 73)*

Essentially, Infraco's obligations are to:

1. throughout the Project, make arrangements to secure improvements in the conduct of the works in particular regard to economy, efficiency and effectiveness
2. prepare best value performance plans and conduct best value reviews and support and assist tie in its preparations for that; and
3. comply with requests for information, data or other assistance by tie in pursuance of tie's best value assessment.

There was no evidence in any of the audits to suggest that these plans and reviews had taken place or that Infraco had actively taken any measures to satisfy its best value obligations. Infraco were unable to produce any letters, memos, emails of minutes of meetings to evidence this obligation. Infraco stated (as an aside) that Best Value for tie and for Infraco were two different things and appeared unaware of the existence and relevance of Clause 73 of the Infraco Contract. Searches of their BIW document archive system conducted by Colin Brady failed to reveal any supporting documentation. Further follow up meetings asking for the details of how they have considered Best Value in their design activities did not produce anything that demonstrated the discharge of these contractual obligations. The Infraco final position was an expression of it (Best Value) "being inherent in everything they do".

Infraco may disagree with this finding, citing the design for Roads as a demonstration of their delivery of Best Value. Whilst tie would agree that the current design intent presents better value now than the design from earlier in the programme, there was little evidence to suggest that there have been any further Best Value initiatives developed since the development workshop.

The final outputs have produced designs that appear to be in excess of the needs of the Client.

As an example, the design of the ground improvement layer beneath the track has produced a product that appears to be in excess of the needs of the tramway. Infraco have designed a reinforced concrete ground improvement layer capable of spanning 1 metre voids. Whilst tie agrees there may be a requirement for void spanning in some areas, tie is unable to accept that this is required throughout the whole on-street route as proposed by Infraco. There was no evidence to demonstrate that Best Value had been considered nor that any risk analysis had been undertaken and presented to the Client as an opportunity to reduce cost of both the direct construction of the tramway and the diversion/protection of utilities.

The development of the design of the OLE has produced a final product but again no evidence was presented to demonstrate that the current design offers Best Value.

There was no evidence to suggest that the contract incentives contained in Clause 81 have prompted any positive behaviour in this area.

No acceptance of liability for Pre-Novation Issues

Infraco have taken a position with regard to pre-novation matters of design by allowing designs to be finalised without any intervention by themselves as the new owners of the design process. They have not demonstrated evidence to suggest that unresolved legacy issues prior to novation should warrant any management or direction by the consortium and that they have attempted to mitigate the impact of changes to the Client - e.g. Bankhead Drive Retaining Wall.

There was very little evidence to suggest that Infraco have challenged pre-novation designs to try and make a difference to the outcome and thus add value to the process.

Lack of Engagement with the Audit Process

Infraco have displayed a reluctance to engage positively with the audit process although they have generally managed to field the necessary personnel to support the audit when required. Access to their BIW system was always available and relevant results printed, however the searches were carried out by Infraco as a working knowledge of the system was required. The contract obligation is for Infraco to provide information, not for tie to discover it, with tie unable to accept responsibility for information not being provided which could and should have been provided during these audits. Some of the requests for information were prefaced by reference to there being a lack of understanding of the relevance of the request.

Design Change Audit – Roads (Section 1D)

1. Audit Team

Robert Bell – tie	Colin Brady – BSC
Colin Matlock – tie	Alan Dolan – BSC/SDS
Donny Mackinnon – tie	Jim Donaldson - BSC
Joanne Glover – DLA Piper	Simon Nisbett - BSC
Tom MacKay – AECOM	Balthazar Ochoa - BSC

2. Scope of audit

During January and February 2010 tie undertook an audit of the ETN Infraco Contract under Clause 104 in relation to Changes to the design of roads construction in Section 1D of the Infraco Works following Development Workshops.

The critical success factors / objectives of the audit were to:-

Item 1 – Understand the rationale and source of the Design Change

Review of evidence to substantiate why the IFC design constitutes a Change under the Infraco Contract

Review of evidence as to whether change emanated from Infraco, an approval body, or client instruction.

Item 2 – Understand the process for design programme management in terms of time, cost and value management

Confirm and evidence that delivery of the IFC was not delayed by late or inadequate instruction or information from Infraco members or subcontractors (including SDS) or any other third party.

Confirm and evidence that Infraco and the SDS Provider considered how a change could be mitigated in terms of cost and time and how they considered best value.

Item 3 – Identify how the design approval process has been followed

Review of evidence that Planning, technical approvals and close out of informatives was completed prior to IFC

Provide evidence that the Programme obligations for the changed design have been discharged.

Demonstrate process for carrying out an Inter Disciplinary Review [IDR] including how integration of the Siemens design was carried out.

Provide copy of Buildability reports and evidence of CDM & ROGS compliance.

3. Audit findings

3.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to understand why the design of the Roads in Section 1D had changed and how the change had transpired.

Findings

It is understood that the original BDDI design differed from the Infraco Proposal. The parties acknowledged, from the outset of the contract, that this BDDI did not represent best value and that economies could arise during completion of the design.

Infraco were obliged to re-design the roads following Development Workshops. The result of Development Workshops was the production of revised pavement options ('the palette')[1] and a flow-chart showing four stages of procedure, agreed by the parties, to address the differing requirements that may arise during the works associated with Roads, including those of Section 1D and culminating in the production of the final design based on the selected palette option. The final version of the palette is outstanding from Infraco.

The Roads Development Workshops caused tie Change Order 19 to be issued changing the methodology by which the road works would be repaired and / or reconstructed. IFC will now no longer be achieved for Roads prior to the start of construction as the final design solution cannot be determined until works have commenced and the road opened up for analysis.

3.2 Item 2 – understand the process for design programme management in terms of time, cost, and value management

Infraco were unable to demonstrate, to tie's reasonable satisfaction, any degree of pro-active management of the design process in terms of time. In terms of cost and value management, it is considered that procurement of Best Value has, partially, been met, however Infraco's engagement in this process has not been pro-active.

Findings

A design change process was agreed between tie and Infraco in Development Workshops, and which was then instructed by tie. This process was explained graphically in a flow-chart. Briefly, an initial design for each section of road would be developed following initial testing of the ground. The parties would collaborate on the condition of existing pavement and on what further soil testing would be suitable.

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[1] *'Appendix 7.1'.*

Test results would be analysed and an agreed choice would then be made from the palette of pavement options, suitable for the conditions found.

Design prioritisation and programming[2] was evidenced as a basic process to achieve completion dates. This programme could not be linked in or coordinated with an overall master programme. There was no evidence of reviewing/updating/ challenging SDS to adhere to the prioritisation list identified in April 2009.

In terms of cost and value, Infraco is of the view that the palette of pavement options demonstrates that best value has been sought and obtained. tie is of the view that the design process represents Best Value in that it permits the most suitable option for any given condition to be obtained, however, the current palette does not. The reasons for this is that it could be improved in that it does not provide guidance on where non-full-depth reconstructions could be used nor on where specific options should be used in terms of those within any given category (the categories could be more defined).

The IFC information for the roads had been due for issue in June or July 2009, based on testing being done up-front. Infraco considered that any delay in the process is the result of a failure to agree (a joint responsibility) the product of the Development Workshops and other aspects such as drainage, traffic signalling and Traffic Regulation Orders. In terms of programming, no programme was being maintained but, rather, a priority list was developed and used for reference. Evidence of this comprised an email from Infraco to Bob Bell in relation to the Prioritisation Order for Drainage Approval and Roads Close out Report, dated 1 April 2009, and table "Design Completion" listing each section and the quarter date by which the design is required. Infraco relied on this, together with the occurrence of the weekly Design Meetings, as evidence that the programme had been managed. The minutes of these meetings do not make any reference to programme or prioritisation.

tie's view is that Infraco have been obstructive in continuing to refuse to consider suggestions to use a cement-bound sub-base to improve bearing capacity and to develop a further option to cater for an intermediate CBR rating of between 5 and 10%, which, in the view of tie's technical expert, may provide a more cost-effective design solution. This could have been easily done within a relatively short period of time but, after one year, it is still outstanding. Infraco appear to have been significantly dilatory in the execution of the palette of pavement options, with the exception that SDS departed from the agreed 3% CBR banding, instead designing to 2.5%. This may not achieve Best Value for tie. The options for tie to pursue this with Infraco will be further explored outwith this audit report.

tie technical advisors, AECOM were asked to comment on the adequacy of the design process. The non-provision of information by Infraco in response to the audit questions have severely restricted the ability of AECOM to comment on the management of the design process, but in the absence of such information it can only be concluded that there is no evidence that the process has been managed adequately.

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[2] SDS Design Programme ULE90130-SW-PRO-00010 V45

3.3 Item 3 – Identify how the design approval process was followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

tie initially agreed to some additional testing to help inform the design in addition to providing information to assist in programming traffic management. Bilfinger Berger considered that the frequency of the proposed initial testing was too high.

The design has not yet been fully approved by all parties although they have been brought along in the process from the Roads Development Workshop. The selection flowchart provides a clear process to achieving a specific design once a road has been opened up.

When works on site commence Infraco intend to seek approval for the selected palette option when they have opened a road up and tested the formation. They were unable to demonstrate an approval process that would avoid delay and especially in consideration that approvals would need to be sought external to Infraco.

With respect to integration and buildability reports, those for the roads do not exist as no AIP process has been followed: they will form part of the CDM compliance[3]. Infraco intend to demonstrate ROGS compliance at the end of the construction works, before revenue running starts.

4.0 Review of Evidence

Review of evidence provided in the audit 21st January 2010 and follow up meeting 2nd February 2010.

Pavement Evaluation Report, reference 718376/R/01/A – Mouchel 8th September 2008. This report was commissioned by Bilfinger Berger UK Ltd to undertake a pavement investigation of four sections of carriageway; Haymarket Junction,

[3] Under the Road Safety Audit.

Shandwick Place, Princes Street and St Andrews Square. The aim was to determine the structural condition of existing pavements and assess their pavement life and propose structural treatments to bring them up to the required design life. Whilst the sample size compared with the length of the 'on street' section was limited a range of conditions was observed from 'deep Inlay or reconstruction' through to an area of 'no treatment'. *(Report not presented in the audit as evidence).*

As a consequence of the Roads Development Workshop, Design Change Order DCO-019, dated 17th February 2009 instructed the production of a Construction Methodology statement to define the management process of a) Testing insitu to determine ground conditions, & b) Selection of Road Construction details, in accordance with tie letter 18th December 2008 547. *(Letter not presented in the audit as evidence).*

As a consequence of the Roads Development Workshop, Design Change Order DCO-020, dated 17th February 2009 instructed the Analysis of Roads Construction.

IDR/IDC meeting minutes – 30th September 2009, 9th November 2009, 16th November 2009 - were presented as evidence of the IDR process for section 1A and that it is complete. The completeness of the process is not evidenced by these documents, only that there is a forum attended by Bilfinger Berger UK and Siemens for IDR/IDC discussion.

Email dated 1st April 2009 from Infraco to tie confirming the prioritisation order for Scottish Water and CEC Roads close out reports, listing the order of the sections of the tram route to be designed from highest to lowest priority. Table entitled "Design Completion" (undated) provides target dates for design completion broken down in to sections of the tram route and quarters (from 1 April 2009 to 1 July 2010).

SDS Design Programme dated 18th May 2009 provided as evidence of how the Roads IFC design process links in with the Infraco requirements. It was not clear to the audit party how this demonstrated any link with the Infraco programme.

Letter dated 29th January 2010, 4828 Infraco write to tie with responses and enclosing supporting evidence to close outstanding actions from the audit.

tie's technical experts reviewed the design protocol and commented on Appendix 7.1. to the effect that the design protocol was considered to be an appropriate methodology and if implemented correctly should provide 'best value'. Opinion is expressed that it is unclear why Appendix 7.1 has taken so long to develop, it being reasonable to suggest that it could have taken a fraction of the time. The development appears to have been led by suggestions from tie or CEC with little evidence of a proactive engagement by Infraco. The band width of options within the design palette has not been narrowed sufficiently to provide economic selection options.

Design Change Audit – Structures

1. Audit Team

Robert Bell – tie	Colin Brady – BSC
Colin Matlock – tie	Alan Dolan – BSC/SDS
Donny Mackinnon – tie	Balthazar Ochoa - BSC
Joanne Glover – DLA Piper	Martin Hutchinson - BSC
Robert Rocke – AECOM	Kate Shudall- BSC/SDS

2. Scope of audit

During January and February 2010 tie undertook an audit of the ETN Infraco Contract under Clause 104 in relation to changes to the design of four structures:- Baird Drive Retaining Wall, Bankhead Drive Retaining Wall, Depot Access Road Bridge & A8 Underpass.

The critical success factors / objectives of the audit were to:-

Item 1 – Understand the rationale and source of the Design Change

Review of evidence to substantiate why the IFC design constitutes a Change under the Infraco Contract

Review of evidence as to whether change emanated from Infraco, an approval body, or client instruction.

Item 2 – Understand the process for design programme management in terms of time, cost and value management

Confirm and evidence that delivery of the IFC was not delayed by late or inadequate instruction or information from Infraco members or subcontractors (including SDS) or any other third party.

Confirm and evidence that Infraco and the SDS Provider considered how a change could be mitigated in terms of cost and time and how they considered best value.

Item 3 – Identify how the design approval process has been followed

Review of evidence that Planning, technical approvals and close out of informatives was completed prior to IFC

Provide evidence that the Programme obligations for the changed design have been discharged.

Demonstrate process for carrying out an Inter Disciplinary Review [IDR] including how integration of the Siemens design was carried out.

Provide copy of Buildability reports and evidence of CDM & ROGS compliance.

3.0 Baird Drive Retaining Wall

3.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to obtain an understanding from the consortium why the design of the retaining wall had changed to its current design.

The audit team requested that the consortium provide details and evidence in support of the design rationale and details of calculations that drew them to the current design conclusions.

It was anticipated that the consortium would be able to outline and demonstrate the design processes they had gone through and the selection of options with risk assessments they had carried out to bring them to the current IFC design solution.

Findings

Infraco/SDS advised that the output design was driven by a Parliamentary Undertaking to maintain a 3m wide space between the residents gardens and tram infrastructure. Despite seeking confirmation of this undertaking there is no evidence to suggest that this is the case.

A change was instructed by tie following the review of an options report and negotiations with Network Rail to agree the routing of the tram tracks adjacent to a maintenance access road.

The change is a shift in the access road away from the NR tracks. The picture is complicated by a change in foundation depth at IFC stage and an apparent change in survey information. The IFC geometry maintains a space along the corridor at the toe of the wall. Whilst this will provide access for the maintenance of the embankment, it does not provide Best Value and has been driven by Infraco/SDS's error in believing there was a parliamentary undertaking in this respect. Access for maintenance can be achieved from the top of the embankment.

3.2 Item 2 – Understand the process for design programme management in terms of time, cost and value management

The audit sought to obtain an understanding from the consortium how they managed the design process in terms of ensuring that the designs were economic, of good value, approved and delivered in a timely manner to support the overall construction programme.

The audit team requested that the consortium provide details and evidence to show how they directed the programme to ensure that it remained on target showing details of how they ensured that good value management had been included to achieve best value to the client.

It was anticipated that the consortium would be able to outline and demonstrate the design programme and demonstrate how they had introduced best value options into the process to deliver an efficient and economic end product.

Findings

The options report focused on the layout options and did not consider cost benefit. The final solution was based upon what was achievable and agreeable with Network Rail. The mis-conception that Infraco/SDS had to comply with a Parliamentary Undertaking is evidence that a cost effective design or Best Value has not been able to be demonstrated.

3.3 Item 3 – Identify how the design approval process has been followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

The current design was developed from a previous IFC design and was varied and approved for IFC. No evidence of design integration of the Infraco Proposal was provided.

4.0 Bankhead Drive Retaining Wall

4.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to obtain an understanding from the consortium why the design of the retaining wall had changed to its current design.

The audit team requested that the consortium provide details and evidence in support of the design rationale and details of calculations that drew them to the current design conclusions.

It was anticipated that the consortium would be able to outline and demonstrate the design processes they had gone through and the selection of options with risk assessments they had carried out to bring them to the current IFC design solution.

Findings

The driver for the change to the South wall was an increase in footway width to incorporate its use as a cycleway and the relocation of the tramstop. This caused several consequences in the structural design of the retaining walls.

The principal changes from BDDI and IFC are re-positioning the South wall further back into the embankment and the addition of a North retaining wall which replaces an embankment. This change increases the height and length of the South wall and the depth to the foundation for compacted fill below.

The foundation level at IFC has been taken at a lower level over the western end of the wall, where the wall is of lesser height.

The North wall was added at IFC. The consortium stated that this addition was to resolve the need to satisfy Network Rail in relation to the BDDI arrangement where the embankment encroached upon their land thus requiring Network Rail approvals.

4.2 Item 2 – Understand the process for design programme management in terms of time, cost and value management

The audit sought to obtain an understanding from the consortium of how they managed the design process in terms of ensuring that the designs were economic, of good value, approved and delivered in a timely manner to support the overall construction programme.

The audit team requested that the consortium provide details and evidence to show how they directed the programme to ensure that it remained on target showing details of how they ensured that good value management had been included to achieve best value to the client.

It was anticipated that the consortium would be able to outline and demonstrate the design programme and demonstrate how they had introduced best value options into the process to deliver an efficient and economic end product.

Findings

The South Gyle tramstop change was requested by CEC and instructed by tie to be relocated despite a report by SDS recommending that it remain in its original designed location[4]. These instructions were made by tie prior to BDDI (25th September 2007).

[4] ULE90130-05-REP-00179V1

The consequences of this relocation in terms of design alterations and cost were not considered in the report and do not appear to inform the decision to instruct the change.

There was no evidence to suggest that the Consortium attempted to advise the Client of the consequences of the change decision and / or any attempt to mitigate the impact of this change.

There was no evidence to demonstrate that Best Value and Value Engineering has been applied to the Design Changes to minimise the cost impact of variations.

4.3 Item 3 – Identify how the design approval process has been followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

The final design was developed and modified during the IFC process with the North wall being added late in the design development stage.

The height of the retaining walls was altered as an original consequence of relocating the tramstop although there was little or no evidence to confirm this difference between BDDI and IFC details.

The current design was presented in the audit as the result of a design process to achieve IFC but the process itself was not evidenced .

5.0 Depot Access Road Bridge

5.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to obtain an understanding from the consortium as to why the design of the structure had changed to its current design.

The audit team requested that the consortium provide details and evidence in support of the design rationale and details of calculations that drew them to the current design conclusions.

It was anticipated that the consortium would be able to outline and demonstrate the design processes they had gone through and the selection of options with risk assessments they had carried out to bring them to the current IFC design solution.

Findings

The revised design was developed post BDDI as a consequence of moving the Depot northwards, resulting in a reduction of the length of the A8 retaining structures from 380m to 75m. This greatly reduced the construction work adjacent to the A8 Slip Road and was one attraction for moving the Depot northwards. The retained height was also reduced from typically 8m to around 6m. The nearest rail on the outbound running lines is now around 17m from the nearest kerb line of the Gogar roundabout compared with around 6m with the pre BDDI v3 design. In theory this should mean a simpler bridge deck in plan shape because there should be less flare at the roundabout end, and at least 10m more working space to construct the South Abutment. The change from secant bored piles to a conventional abutment on 900 diameter bored piles combined with the temporary anchored wall and associated working space has eaten into at least 5m of the additional working space created by moving the Depot northwards.

AECOM commented on the re-design as follows:-

- There would appear to be no reason why secant (or contiguous) bored piles could not have been used for the abutments and retaining walls of the post BDDI v4 design in a similar way to the pre BDDI v3 design.
- Permanent ground anchors could probably have been eliminated by making the deck fully integral with the abutments and pier. This would also eliminate bearings and have other maintenance benefits as well.
- As an alternative to embedded piles for the abutments, spread foundations on the boulder clay would seem to be a feasible option eliminating the need for bored piles.
- Another option could have been a two cell reinforced concrete box which would have a low bearing pressure and would take the south side excavation further away from the Gogar roundabout and reduce the height of the temporary earth support required.

5.2 Item 2 – Understand the process for design programme management in terms of time, cost and value management

The audit sought to obtain an understanding from the consortium how they managed the design process in terms of ensuring that the designs were economic, of good value, approved and delivered in a timely manner to support the overall construction programme.

The audit team requested that the consortium provide details and evidence to show how they directed the programme to ensure that it remained on target showing details of how they ensured that good value management had been included to achieve best value to the client.

It was anticipated that the consortium would be able to outline and demonstrate the design programme and demonstrate how they had introduced best value options into the process to deliver an efficient and economic end product.

Findings

There was no evidence to suggest that the Consortium attempted to advise the Client of the consequences of the change decision and / or any attempt to mitigate the impact of this change.

There was little evidence to demonstrate that Best Value and Value Engineering has been applied to the Design Changes to minimise the cost impact of variations. BSC did not participate in any VE or Best Value review, and cite time being against them in that respect (ie difference between contract signing and submission of IFA).

5.3 Item 3 – Identify how the design approval process has been followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

The final design was presented in the audit as the result of the design process to achieve IFC but not as evidence of how the design approval process was followed.

6.0 A8 Underpass

6.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to obtain an understanding from the consortium why the design of the structure had changed to its current design.

The audit team requested that the consortium provide details and evidence in support of the design rationale and details of calculations that drew them to the current design conclusions.

It was anticipated that the consortium would be able to outline and demonstrate the design processes they had gone through and the selection of options with risk assessments they had carried out to bring them to the current IFC design solution.

Findings

The consortium was not prepared to provide any evidence to support the audit on this topic. tie do not agree with BSC's position on this matter and have written separately stating their position.

6.2 Item 2 – Understand the process for design programme management in terms of time, cost and value management

The audit sought to obtain an understanding from the consortium how they managed the design process in terms of ensuring that the designs were economic, of good value, approved and delivered in a timely manner to support the overall construction programme.

The audit team requested that the consortium provide details and evidence to show how they directed the programme to ensure that it remained on target showing details of how they ensured that good value management had been included to achieve best value to the client.

It was anticipated that the consortium would be able to outline and demonstrate the design programme and demonstrate how they had introduced best value options into the process to deliver an efficient and economic end product.

Findings

The consortium was not prepared to provide any evidence to support the audit on this topic. tie do not agree with BSC's position on this matter and have written separately stating their position.

6.3 Item 3 – Identify how the design approval process has been followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

The consortium was not prepared to provide any evidence to support the audit on this topic. tie do not agree with BSC's position on this matter and have written separately stating their position.

7.0 Review of Evidence

Review of evidence provided in the audit 19th January 2010 and follow up meetings 27th January 2010 and 22 February 2010.

SDS Client/Design Meeting Minutes provided on request to demonstrate the development of the design.

17th July 2008
30th July 2008
6th August 2008
13th August 2008
20th August 2008
27th August 2008
3rd September 2008
10th September 2008
17th September 2008
24th September 2008
1st October 2008
5th October 2008
8th October 2008

Letter 11th August 2008, SDS write to Infraco forwarding CD copies of IFC drawings for A8 Underpass.

Letter 18th August 2008, SDS write to Infraco forwarding further CD copies of IFC drawings for A8 Underpass. – previous copy was corrupt.

Letter 9th September 2008, SDS write to Infraco issuing Change Estimate DCR0010 for Additional Prior Approvals for Depot Access Bridge.

Baird Drive Retaining Wall

SDS report (PB) dated 21st December 2007 – Network Rail Balgreen Road Options Report. Three options considered. Report assumes a minimum clearance of 2.5m between toe of embankment and the garden fence. A vertical retaining wall is proposed where the clearance would fall below this minimum.

Letter circa 25th April 2007, tie write to Network Rail confirming that the design is proceeding on the basis of the "high level" option.

Letter 16th May 2007, 373A tie write to SDS confirming that they should be continuing to progress the design based upon alignment option 3.

Letter 21st August 2007. Network Rail write to tie confirming that the current alignment is the best all round option. The current position affords Network Rail a maintenance access road and permission to reverse maintenance road vehicles over the tram tracks.

Project Change Order dated 24th January 2008 issued by tie to SDS with the intent of changing the alignment in accordance with letter 16th May 2007 373A .

Change Estimate CES231 dated 29th November 2007 issued by SDS for the change of alignment in accordance with letter 16th May 2007 373A .

Document Transmittal Form dated 1st August 2008, SDS to tie, issues IFC drawings for Baird Drive.

Email 22nd January 2010, SDS write to tie with audit briefing notes for the Baird Drive, Bankhead Drive and Depot Access Bridge. Also confirms that A8 Underpass details will be responded to separately.

Bankhead Drive Retaining Wall

Letter 26th October 2006, 44220 tie write to SDS enclosing SDS report (PB) dated 5th October 2006 – South Gyle Tramstop Design Approval Panel Comments & Appraisal of proposed move of Tramstop Report. The report concludes that there is no justification for removing or locating the Stop further east at Broomhouse Drive.

Letter 3rd November 2006, CEC write to tie informing them of their requirement for the tramstop to be relocated to improve the bus interchange with the tram. *(Not presented as audit evidence)*

Letter 1st December 2006, 61228 tie write to SDS instruct an adjustment in the tramstop location. *(Not presented as audit evidence)*

Letter 23rd March 2007, 59048 tie write to SDS confirming agreement to proposed location. *(Not presented as audit evidence)*

Letter 25th September 2007, tie write to SDS return the Change Notice (24th September 2007) and Change Order asking for them to be signed and returned.

Depot Access Road Bridge

Change Order dated 31st July 2007 issued to SDS to undertake a study and review the moving of the depot building within the Gogar site.

SDS report (PB) dated 16th August 2007 – Gogar Depot Report "Possible Adjustments" recommends that tie should instruct for the relocation of the depot building within the Gogar site.

Change Order dated 12th September 2007 issued to SDS to carry out the recommendations to relocate the depot building within the Gogar site.

A8 Underpass

The Consortium were not prepared to provide any evidence on this topic other than the two letters referred to on page 21. tie do not agree with BSC's position on this matter and have written separately stating their position.

Design Change Audit – Track Design and Improvement Layers

1. Audit Team

Robert Bell – tie

Colin Matlock – tie

Donny Mackinnon – tie

Willie Biggins - tie

Joanne Glover – DLA Piper

Robert Rocke – AECOM

Colin Brady – BSC

Alan Dolan – BSC/SDS

Jason Chandler - BSC

Shabu Dedhar - BSC

Balthazar Ochoa - BSC

2. Scope of Audit

During January and February 2010 tie undertook an audit of the ETN Infraco Contract under Clause 104 in relation to Changes and differences in Design as it pertains to the Track Design and Improvement Layers.

The critical success factors / objectives of the audit were to:-

Item 1 – Understand the rationale and source of the Design Change

Review of evidence to substantiate why the IFC design constitutes a Change under the Infraco Contract.

Review of evidence as to whether change emanated from Infraco, an approval body, or client instruction.

Item 2 – Understand the process for design programme management in terms of time, cost and value management

Confirm and evidence that delivery of the IFC was not delayed by late or inadequate instruction or information from Infraco members or subcontractors (including SDS) or any other third party.

Confirm and evidence that Infraco and the SDS Provider considered how a change could be mitigated in terms of cost and time and how they considered best value.

Item 3 – Identify how the design approval process has been followed

Review of evidence that Planning, technical approvals and close out of informatives was completed prior to IFC

Provide evidence that the Programme obligations for the changed design have been discharged.

Demonstrate process for carrying out an Inter Disciplinary Review [IDR] including how integration of the Siemens design was carried out.

Provide copy of Buildability reports and evidence of CDM & ROGS compliance.

3. Audit Findings

3.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to obtain an understanding from the consortium why the design of the trackform had changed and what the thinking was behind the current proposal of constructing a reinforced concrete slab underneath the trackslab.

The audit team requested that the consortium provide details and evidence in support of the design rationale and details of calculations that drew them to the current design conclusions.

It was anticipated that the consortium would be able to outline and demonstrate the design processes they had gone through and the selection of options with risk assessments they had carried out to bring them to the current IFC design solution.

Findings

The consortium has not followed the tie instruction to produce a suite of design options for a track improvement layer.

The consortium has considered that the current design of track and ground improvement layer is a result of the Infraco Proposal and the design Development Workshop to identify and resolve design mis-alignments.

Infraco's track design is the Rheda City sleeper system which comprises pre-cast concrete bi-block sleepers with exposed interconnecting reinforcing bars for insitu concrete casting in position on site. The design requires a ground bearing capacity on street of 120MN/m^2.

Four mis-alignments between Base Date Design Information and the Infraco Proposals were identified and dealt with in the design Development Workshop (Report Issued 12th March 2009).

1. Rail Sections.
2. Vibration Performance.
3. Ballast Shoulder Dimensions.
4. Ground Improvement Layer.

tie instructed the consortium to produce a menu of generic designs for a Ground Improvement Layer to meet the need for the 120MN/m2 ground bearing capacity. The suite of designs was to provide alternatives based upon perceived level of risk and consequences for both void spanning and non-void spanning. They were to assume void spanning in the city centre (as a worse case scenario) and no void spanning for out of town areas for design purposes and subject to confirmation. A specific design option was to be selected based upon the discovery of ground conditions as works proceed.

The consortium have only produced one ground improvement design option based upon their unsubstantiated assumption that the entire length of the on-street section will have a sub-standard ground bearing capacity and will require void spanning of 1m in any direction. This design comprises a reinforced concrete ground bearing slab to the underside of the insitu concrete track slab along the entire length of the on-street section. The suite of options has not been produced and the consortium has confirmed to tie that they are not going to consider any other ground improvement options. The consortium's position is that SDS attempted to consider the alternative void spanning options and came to the conclusion that they would not be workable.

The consortium has however recently issued a design proposal to tie for a floating slab arrangement to deal with specific noise and vibration issues in certain areas. The noise and vibration issue has arisen from the stiffer track parameters required by the Rheda City system as well as the large mass of concrete as a consequence of the reinforced concrete ground improvement layer. Whilst this proposal is intended for short and specific lengths of the tramway it does introduce reinforcing bars into the track slab thus reducing the need for such a strong improvement layer. This proposal has been submitted to tie for consideration.

No evidence was presented by Infraco that demonstrated they had made any attempt to comply with Schedule Part 23, Appendix Part 7, Part C

"PB will provide a suite of treatments which can be applied when the requirements are established by BBS. Note that this scope of work will be impacted by the lower void spanning capacity of BBS's Trackform offering in comparison with the PB reference design".

3.2 Item 2 – Understand the process for design programme management in terms of time, cost and value management

The audit sought to obtain an understanding from the consortium how they managed the design process in terms of ensuring that the designs were economic, of good value, approved and delivered in a timely manner to support the overall construction programme.

The audit team requested that the consortium provide details and evidence to show how they directed the programme to ensure that it remained on target showing details of how they ensured that good value management had been included to achieve best value to the client.

It was anticipated that the consortium would be able to outline and demonstrate the design programme and demonstrate how they had introduced best value options into the process to deliver an efficient and economic end product.

Findings

A design programme has not been utilised or maintained to deliver the trackform in a timely manner.

The consortium does not have an agreed design programme for trackform and consider that they are carrying out the design work on a priority basis. They cite the absence of an agreed Programme with tie as being the reason for a lack of design programme.

In the absence of an agreed design programme, there is no evidence of delivering this design to a programme. There are some examples of an exchange of letters between the consortium and SDS urging attention to specific matters that need attention but nothing to suggest that key dates and deliverables were agreed with the SDS design team.

A review of correspondence and minutes of meetings would suggest that the SDS design team are being instructed to produce designs and variations on the basis of letters. Design reviews are being undertaken when a design is ready and recorded in a set of meeting minutes. It could not be verified from the evidence presented that the reviews considered Best Value or value engineering alternatives in the discussions.

Changes in design have been communicated within the consortium by an exchange of letters. There was no evidence to suggest that the design and/or variations were undertaken to achieve Best Value.

The audit team were unable to verify that the design has been managed against a set of programme requirements or deliverable expectations. There was no evidence presented to suggest that value engineering has been applied and Best Value options have been considered to the benefit of the Client. It cannot therefore be confirmed that the current designs provide an efficient and economic end product.

3.3 Item 3 – Identify how the design approval process has been followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

The audit determined that the process to manage design integration was not applied to the trackform design until it was too late in the process to inform the design.

The selection and design of the trackform appears to have been determined without due consideration on how the sub-base would be designed and achieved to meet the requirements of the trackform.

Interface Control Forms (ICF) have been generated during the design process but were not able to evidence that an iterative integrated process of review and rework had taken place to achieve the most effective and economic design suitable for the ground conditions and environment of the ETN.

The evidence suggests that a design has been dictated based upon SDS's view of "good engineering judgement" and the specific requirements of another Tram project (Nottingham) rather than any technical rationale based upon risk assessment or consequential analysis. The "engineering judgement" has not been supported by Industry Standards, Design Guidance Notes, Technical Papers or operational/statistical evidence gathered from other Tram projects. The experience of opening up Princes Street was cited as the justification of the design (confirming what SDS had anticipated in its engineering judgement) but there was no evidence to suggest that there is a continuous improvement process in place to capture previous findings and inform future design.

4.0 Review of Evidence

Letter 18th December 2008, 548 tie instructs Infraco to provide generic options of design solutions for ground improvement layer to suit Rheda City track design.

Letter 11th March 2009, 1887 Infraco write to tie enclosing copies of the output from the Trackfrom Design Development Workshop held to address mis-alignments. Mis-alignment No. 4 confirms the 120MN/m^2 requirement and the need for an improvement layer. SDS to design "menu" of improvement layers to be instructed on site as excavation proceeds. Design to include for vibration isolation. Mis-alignment No. 2 instructs SDS to investigate the consequences of Vibration with the change of trackform to Rheda City. The report indentified that Infraco may require an instruction to install floating track mitigation.

May 2009 – tie lead a design review of the track design and raise questions over the adequacy of the proposed design including improvement layer. *This document was not part of the evidence presented by Infraco.*

Letter 27th March 2009, 050409 Infraco write to SDS with reference to some important activities having slipped SDS attention.

Letter 16th April 2009, 062911 Infraco write to SDS expressing concern that SDS have not been acting upon or responding to important matters raised in previous letters.

Letter 17th July 2009, 053198 Infraco write to tie with responses as required from the tie Design Review (May 2009). *This letter was not part of the evidence presented by Infraco.*

Letter 28th July 2009[1], 3154 Infraco write to tie confirming details of a general issues meeting on 27th July requesting an auditable trail of documentation leading to the RC slab as the only solution for the improvement layer. They confirmed that this documentation exits in an email and are checking their records.

Letter 28th July 2009 3155 Infraco write to SDS contending that only one solution has been provided, contrary to change request 0125. SDS asked to document the design development process including copies of calculations.

Letter 11th August 2009, 1948 tie write to Infraco in response to the answers provided (27th July 2009) in the Design Review complaining about the lack of integration of design and their concern for the adequacy of design and makes specific reference to the track design and their expectation of a fuller and integrated response to the review question. Infraco have not responded to this letter. (*This letter was not part of the evidence presented by Infraco).*

Email 14th August 2009, Infraco send tie a copy of an internal Infraco briefing document which refers to the BDDI design, a Two Stage Slab Trackform which has a RC slab underneath a RC slab containing the rails. The sub-base is conditioned with a cement bound granular material. Reference is made by Infraco this being as per Nottingham tram with a capability of void spanning of 1m. The document highlights the Infraco proposal of Rheda City track form and its benefits such as warranty of track quality and reliability as well as its adaptability for all alignments and its ability to be covered with various finishings. Minimization of structure-borne noise is also cited as a benefit. (*This email was not part of the evidence presented by Infraco).*

Advance copy Letter 24th August 2009, SDS reply to above letter advising the rationale for the RC slab being the only solution for void spanning and prevention of catastrophic collapse of the track. They confirm to Infraco that calculations are available for inspection and audit off site. They also state that tie requested Infraco at a meeting on 20th August 2009 to do further investigation into the design concept of using reinforcement in the track slab. SDS contended that this would not achieve 120N/m2 and asked Infraco to resolve this anomaly.

Letter 25th August 2009, 3347 + attachment. Infraco write to tie to confirm that contrary to previous statement, they do not have email confirmation (by implication any confirmation) from SDS that the RC improvement layer is necessary – only an advance copy of a letter of the previous day (24th) which was in response to the immediate request. Post audit note - tie have responded to this letter (INF CORR 4114 refers).

Letter 1st September 2009, 3402 Infraco write tie to confirm that they are producing three options/solutions for the track improvement layer. They also confirm that Princes' Street construction will proceed on basis of existing design. (Note earlier suggestion that the selection of the improvement layer will be based on site inspection, 11th March 2009). Post audit note - tie have responded to this letter (INF CORR 4114 refers).

Letter 13th November 2009, 2792 tie write to Infraco acknowledging receipt of Infraco letter 28th July 2009[1] and asking for Infraco to confirm that "the designers only

workable option is for reinforced concrete". Refers to a joint Track technical meeting with an action for Infraco to table a draft design based on LUAS light rail system. It summarises by concluding that "it would appear that the only workable solution may be RC slab but not necessarily throughout the whole route". Recommends a follow up workshop once BAM produce draft design.

Letter 23rd November 2009, 067067 Infraco write to tie with reference to the possibility of putting reinforcing bars in the track slab following a Track Technical meeting on 20th August 2009. Infraco raise a number of disadvantages/risks associated with this idea and confirm that as a consequence they will not be proposing any general use of a reinforced track slab. Note - All the arguments put forward by Infraco against this proposal are demolished by the floating slab design for specific areas submitted on 1st February 2010. Post audit note - tie have responded to this letter. (INF CORR 4114 refers).

Letter 1st February 2010, 057200 Infraco write to tie inviting review comments on a Floating Slab Design proposal to reduce noise and vibration in certain areas. This design demolishes all the arguments put forward in letter 23rd November 2009 against a reinforced concrete track slab. This appears to be in response to mis-alignment No.2. Post audit note - tie have responded to this letter (INF CORR 4114 refers).

Letter 24th February 2010, 4781 Infraco write to tie with responses information to answer the audit follow up questions.

Design Audit – OLE and Foundation Design

1. Audit Team

Robert Bell – tie	Colin Brady – BSC
Colin Matlock – tie	Alan Dolan – BSC/SDS
Donny Mackinnon – tie	Ineke Van Klavern - BSC
Joanne Glover – DLA Piper	John Newton - BSC
Robert Rocke – AECOM	Balthazar Ochoa - BSC

2. Scope of Audit

During January and February 2010 tie ltd undertook an audit of the ETN Infraco Contract under Clause 104 in relation to Changes and Differences in Design as it pertains to the OLE and Foundation design

The critical success factors / objectives of the audit were to:-

Item 1 – Understand the rationale and source of the Design Change

Review of evidence to substantiate why the IFC design constitutes a Change under the Infraco Contract

Review of evidence as to whether change emanated from Infraco, an approval body, or client instruction.

Item 2 – Understand the process for design programme management in terms of time, cost and value management

Confirm and evidence that delivery of the IFC was not delayed by late or inadequate instruction or information from Infraco members or subcontractors (including SDS) or any other third party.

Confirm and evidence that Infraco and the SDS Provider considered how a change could be mitigated in terms of cost and time and how they considered best value.

Item 3 – Identify how the design approval process has been followed

Review of evidence that Planning, technical approvals and close out of informatives was completed prior to IFC

Provide evidence that the Programme obligations for the changed design have been discharged.

Demonstrate process for carrying out an Inter Disciplinary Review [IDR] including how integration of the Siemens design was carried out.

Provide copy of Buildability reports and evidence of CDM & ROGS compliance.

3. Audit Objectives

3.1 Item 1 – Understand the rationale and source of the Design Change

The audit sought to obtain an understanding from the consortium why the design of the OLE and associated foundations had changed to its current design.

The audit team requested that the consortium provide details and evidence in support of the design rationale and details of calculations that drew them to the current design conclusions.

It was anticipated that the consortium would be able to outline and demonstrate the design processes they had gone through and the selection of options with risk assessments they had carried out to bring them to the current IFC design solution.

Findings

The OLE design changed as a result of the Infraco Proposal and the instruction issued by tie arising from the OLE Development Workshop. A change was anticipated under the SDS Novation Agreement. The nature of the change in design with respect to the size of the OLE foundation (it has increased in size and weight) required investigation. tie notes that the number of poles has reduced and that this was also anticipated as a consequence of accepting the Infraco Proposals.

A technical audit of the OLE pole foundation design was undertaken using appropriate technical expertise from AECOM. In summary, their report finds:-

> SDS have presented a reasoned methodology for the base designs that may be required along the tram route. Their design addresses the applied un-factored loads from the poles, vehicular impact and economies/efficiencies that can be achieved where soil strata varies along the route.
>
> SDS have applied appropriate factors of safety as described in relevant codes and standards, to the un-factored loads advised by Siemens, to produce a safe design.
>
> Designs appear to have been undertaken exercising reasonable skill, care and diligence.

3.2 Item 2 – Understand the process for design programme management in terms of time, cost and value management

The audit sought to obtain an understanding from the consortium how they managed the design process in terms of ensuring that the designs were economic, of good value, approved and delivered in a timely manner to support the overall construction programme.

The audit team requested that the consortium provide details and evidence to show how they directed the programme to ensure that it remained on target showing details of how they ensured that good value management had been included to achieve best value to the client.

It was anticipated that the consortium would be able to outline and demonstrate the design programme and demonstrate how they had introduced best value options into the process to deliver an efficient and economic end product.

Findings

A design programme has not been utilised or maintained to deliver the OLE and/or foundation civil design in a timely manner.

The consortium does not have an agreed design programme for OLE and consider that they are carrying out the design work on a priority basis. They cite the absence of an agreed Programme as being the reason for a lack of design programme.

In the absence of an agreed design Programme there is no evidence of delivering to a programme.

Based on the explanations offered at the audit, and a review of correspondence it appears that the design team are being instructed to produce designs and variations on the basis of meetings, without formal minutes. Design reviews are being undertaken when a design is ready and recorded in a set of meeting minutes. It could not be verified from the evidence presented that the reviews considered value engineering alternatives in the discussions.

Changes in design have been communicated within the consortium by an exchange of an Infraco (Siemens) spreadsheet.

There was no evidence to suggest that the design and/or variations were undertaken to achieve Best Value. It cannot therefore be confirmed that the current designs provide an efficient and economic end product.

3.3 Item 3 – Identify how the design approval process has been followed

The audit sought to obtain confidence from the consortium that the design process has been fully integrated and had obtained all the necessary approvals and consents so as not to delay the construction programme and deliver best value.

The audit team requested that the consortium provide details and evidence in support of the system integration processes, change control, design reviews and close out.

It was anticipated that the consortium would be able to produce an activity schedule along with evidence to demonstrate that the necessary steps had been taken to achieve a fully integrated and compliant design.

Findings

The audit determined that the process to manage design integration was applied in a manner which was limited by the different (and opposing) commercial considerations between the consortium members – (including the commercial consideration of SDS), controlled on a day to day basis by Bilfinger Berger.

Interface Control Forms (ICF) have been generated during the design process but were not able to evidence that an iterative integrated process of review and rework had taken place to achieve the most effective and economic design suitable for the ground conditions and environment of the ETN.

4.0 Review of Evidence

OLE design lead by Siemens with SDS addressing the design of the foundation bases.

Design Development Workshop held to address mis-alignment between Infraco Proposal and current requirements.

Change 4 – Location of Poles
Change 5 – Lighting Pole locations
Change 6 – OLE soffit fixing to Depot Access Bridge

Calculation Summary sheets for OLE Pole Loadings

OLE conflict schedule never provided by Infraco. In the absence of a schedule tie instructed SDS to provide a schedule for Leith Walk. (ref Colin Neil, tie)

Numerous Correspondence Infraco - SDS re number and location of poles.

Correspondence Infraco – tie with reference to mis-alignments

Letter 13th January 2009, 060294 Infraco writes to SDS enclosing detailed design document "OCL Layout Drawings and Table of Foundation.

Letter 19th January 2009, 060338 Infraco writes to tie confirming a previous discussion w.r.t. changes impacting the location of OLE infrastructure – mainly Forth Ports requirements and road layout changes. Infraco propose to minimise cost and programme impacts that all changes up to 19th January be incorporated in a single design revision. *(tie reply 12th March 2009)*

Letter 30th January 2009, Infraco writes to SDS with Design Change notice 087.

9th February 2009, SDS issue change notice to Infraco.

23rd February 2009, SDS issues a revised change notice to Infraco.

Letter 26th February 2009, Infraco writes to SDS withdrawing RDC 059 (Gogar Landfill Embankment).

6th March 2009, Infraco agree estimates with SDS

9th March 2009 – 25th June 2009, correspondence Infraco, SDS, Siemens regarding estimates.

Letter 12th March 2009, tie writes to Infraco in response to their letter of 19th January 2009 and accepts the Infraco proposal as a pragmatic way forward for dealing with design changes. *(Not provided as audit evidence by Infraco)*

Letter 17th March 2009, Infraco write to SDS complaining that SDS have allowed three and half months to elapse since they sent tie's comments to them rejecting CEC comments as grounds for a tie change. Infraco confirm that they are holding SDS responsible for delays that may arise in the progress of the works due to late response.

Letter 20th March 2009, 1889 Infraco writes to tie enclosing issue one of the output of the Design Development Workshop. tie asked to accept the conclusions in respect of the identified mis-alignments. *(tie reply 29th April 2009)*

Letter 25th March 2009, Infraco writes to SDS regarding Airport Prior Approvals including poles.

Letter 9th April 2009, Infraco writes to tie enclosing a copy of the Design Development Workshop report. *(Not provided as audit evidence by Infraco)*

Letter 17th April 2009, tie writes to Infraco confirming their acceptance of the Design Development Workshop report. *(See tie letter 29th April which seems to open up the discussion again). (Not provided as audit evidence by Infraco)*

Letter 27th April 2009, 2403 Infraco writes to SDS with request for design change No. 113 to redesign OLE pole foundations and layout due to increased loadings, identified as mis-alignment. Estimate requested.

Letter 27th April 2009, 2404 Infraco writes to SDS with request for design change No. 114 to amend OLE System Design Documents, identified as mis-alignment. Estimate requested.

Letter 27th April 2009, 2405 Infraco writes to SDS with request for design change No. 115 to amend OLE Building Fixings Load and Layout drawings, identified as mis-alignment. Estimate requested.

Technical report dated 26th February 2010 from Aecom discussed the detail behind the foundation design following an inspection of the design methodology and calculations and found it to be appropriate.