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## Transportministeriet, Danmark

# IC4/IC2 Review

**Background Report**
19 October 2011


**Plan Design Enable**

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# Notice

This document and its contents have been prepared and are intended solely for the Transportministeriet's information and use in relation to the assignment for an external review of the IC4/IC2 project. It is based upon documentation and information provided by the parties concerned in the Review and can be relied upon to the extent that the information thus provided can be relied upon.

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## Document History

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# 1. Introduction

## 1.1. Terminology

In this Report, the following terms are used for the main participants in the Review:-

| | |
|---|---|
| AB | AnsaldoBreda (Italy and Danmark) |
| AT | Atkins (Danmark and UK) |
| DSB | Danske Statsbaner (Danish State Railways) |
| IC4PT | DSB IC4 Project Team |
| IC4DT | DSB IC4 Drift (Operations) Team |
| TRM | Transportministeriet (Danish Ministry of Transport) |
| TS | Trafikstyrelsen (Danish National Safety Authority) |

A full Glossary of terms used in this Report is presented in Appendix A1.

## 1.2. Assignment

Transportministeriet, Danmark, has commissioned Atkins to undertake an independent external review of the status of the IC4/IC2 project. The work is being undertaken by Atkins Danmark with support from rolling stock consultants in Atkins UK.

## 1.3. Remit

The Terms of Reference for this external review of the IC4 and IC2 Project were set out in a TRM memorandum on 26 May 11. The requirement for an external review arose due to fundamental uncertainty about the prospects for using IC4 trains as planned in Danish inter-regional traffic. TRM stated that in order to utilise IC4 trains in long-distance traffic it must be possible to couple up to 4 train sets to meet the demand for high speed and Inter-City trains between the regions.

At present, it is possible and approved for two trainsets to be coupled while in passenger service and DSB expects to obtain approval for three trainset coupling before the end of 2011. However, there have been technical and operating problems with two-coupled trainsets and this, together with other quality and technical problems, have created concern that the operational stability of IC4 trains will remain insufficient.

This Review is expected to clarify these issues and the realistic possibilities for correcting them and, in this context, to address the following specific issues:-

- review the status of IC4 and IC2 delivery
- review all current problems with IC4 by:-
    - survey all major technical problems important for the passenger experience in terms of reliability and comfort including problems relating to:-
        - mechanical parts of the train, e.g. gearboxes, brakes, etc
        - coupling of a number of train sets
        - computer problems, e.g. in relation to the train computer, other computers, their interaction with other parts of the train, including failure rate
        - other technical and quality-related problems
        - handling of train sets by the operator
    - uncover all other important problematic issues

- review options for repairing the problems with IC4 including:-
  - the possibilities of rectifying the problems in total or in part including:-
    - time perspective
    - economic consequences
  - assess whether IC4 trains can be put into service in inter-regional traffic as planned
  - consider the current IC4 project organisation and whether it should be changed

Following a presentation of preliminary findings to TRM on 30 Aug 11, we were requested to undertake the following additional tasks:-

- Task 1 Reliability Improvement
  - assess the current processes for reliability measurement, analysis, prediction, and reporting
  - develop a plan for a Reliability Improvement Team in the DSB IC4 Project Team
  - develop a prediction for reliability improvement
- Task 2 Technical Problems
  - further investigate problems with the coupling, brake, door, and HVAC systems
  - verify the current status of investigations and solutions to the axle reversing gear, compressors, IDU, and battery chargers.
  - identify any other technical issues that are likely to have a high impact on reliability

## 1.4. Approach

Our review has been undertaken by a process of meetings and interviews with representatives from AB, DSB, and TS; visits to AB and DSB production facilities in Italy and Danmark; and collection of documentation from AB, DSB, and TS. The review commenced on 29 Jun 11 and encompassed:-

- 55 meetings and interviews
- 5 visits
- 282 documents in the following categories:-
  - approval 21
  - contractual 87
  - information 7
  - maintenance 19
  - operational 8
  - organisational 12
  - production 44
  - quality 7
  - reliability 30
  - safety 7
  - technical 41

The information thus collected has been reviewed and assessed and our findings are reported in the following chapters.

All aspects of the IC4 and IC2 projects are in progress so that data concerning production and modification rates and operational performance are changing all the time. For the purposes of this Review, we have therefore taken a ‘snapshot’ of the status of the projects as at 31 Aug 11.

## 1.5. Schedule

To undertake this Review, we have followed the schedule of activities presented below:-

| Month | Week | Activities | Milestones |
|---|---|---|---|
| Jun | 26 | • Inception Meeting with TRM IC4 Steering Group in København<br>• Meetings and interviews with IC4PT in København<br>• Documentation and data collection | *Steering Group meeting* |
| July | 27 | • Meeting with IC4PT in København<br>• Meeting with TS in København<br>• Meetings with IC4PT in Århus<br>• Meetings and interviews with IC4DT in Århus<br>• Inspection tour of the IC4 maintenance facility in Århus<br>• Inspection tour of an IC4 train set in Århus<br>• Documentation and data collection | |
| | 28 | • Preliminary assessment of information, data, and documentation collected to date<br>• Progress Report No. 1 submitted to TRM IC4 Steering Group | *Progress Report 1* |
| | 29 | • Meetings and interviews with AB and DSB in Pistoia, Italy<br>• Inspection tour of AB's production facilities in Pistoia, Italy<br>• Additional documentation and data collection<br>• Commenced detailed assessment of information, data, and documentation collected to date | |
| | 30 | • Meetings and interviews with IC4PT in Århus<br>• Meetings with IC4DT in Århus<br>• Interview with AB in Augustenborgadde, Århus<br>• Inspection tour of AB's commissioning facility in Augustenborgadde, Århus<br>• Meeting with AB, IC4PT, and DSB TM in Randers<br>• Inspection tour of DSB TM's facility at Randers<br>• Coupling demonstration in Århus<br>• Additional documentation and data collection<br>• Continued detailed assessment of information, data, and documentation collected to date | |
| August | 31 | • Interviews with IC4PT in København<br>• Meeting with Director, DSB Fjern- & Regionaltog in København<br>• Additional documentation and data collection<br>• Continued detailed assessment of information, data, and documentation collected to date<br>• Submission of Progress Report No. 2 to TRM IC4 Steering Group | *Progress Report 2* |
| | 32 | • Interview with TS in København<br>• TRM IC4 Steering Group meeting in København for presentation of Progress Report No. 2<br>• Additional documentation and data collection<br>• Completed detailed assessment of information, data, and documentation collected<br>• Commenced preparation of preliminary findings | *Steering Group meeting* |
| | 33 | • Additional documentation and data collection<br>• Continued preparation of preliminary findings | |
| | 34 | • Additional documentation and data collection<br>• Completed preparation of preliminary findings | |

| Month | Week | Activities | Milestones |
|---|---|---|---|
| September | 35 | • Presentation of preliminary findings to TRM in København<br>• Tasked with additional work<br>• Meeting with IC4PT in København<br>• Additional documentation and data collection | *TRM Meeting* |
| | 36 | • Meetings and interviews with IC4PT in København<br>• Interview with IC4PT and IC4DT in Århus<br>• Additional documentation and data collection | |
| | 37 | • Meetings and interviews with IC4PT and IC4DT in Århus<br>• Additional documentation and data collection | |
| | 38 | • Assessment of additional information, data, and documentation collected<br>• Commenced preparation of Draft Report | |
| | 39 | • Completed preparation of Draft Report<br>• Submission of Draft Report to TRM Steering Group | *Draft Report* |
| | 40 | • Presentation of Draft Report to TRM Steering Group | *Steering Group meeting* |

A full record of all meetings and interviews is presented in Appendix A2.

## 1.6. Documentation

All documents received in the course of the Review have been allocated a Unique Reference Number (URN) and the URN numbers are used throughout this Report for references to relevant documents. Details of all documents received are recorded in URN number order in Appendix A3.

In parallel with meetings, interviews, and reviews of documentation, a Question / Answer process has been used to clarify or follow-up various matters as recorded in Appendix A4.

# 2. Status of IC4 and IC2 Delivery

## 2.1. IC4 Train Delivery by AB

The IC4 and IC2 projects have a complicated history resulting in a complex situation in terms of contractual considerations, train design configuration, train delivery, and type approval. In order to define the current status of the IC4 and IC2 projects in terms of their delivery, it is thus necessary to understand the contractual history.

In 1998, DSB launched a "Good Trains for All" (GTA) programme to expand and upgrade its passenger services. Leading the programme would be the acquisition of a new fleet of DMMUs for long distance inter-regional services which would allow redeployment of the existing IC3 and IR4 trains to increase service frequencies on other Inter-City and inter-regional routes. The programme also included the acquisition of new EMUs and infrastructure improvements, including the development of regional routes around Odense, Århus, Aalborg and Esbjerg. (source – Railway Gazette International)

Following a competitive tendering process, DSB awarded the GTA rolling stock contract to Breda Costruzioni Ferroviarie (AnsaldoBreda (AB) from 2001), an Italian rolling stock manufacturer, in December 2000 (URN 197). Under this contract, AB were to supply 83 x 4-car diesel-mechanical multiple unit (DMMU) trainsets to be designated IC4. The trainsets were to be designed to meet DSB's technical requirements and were intended to replace DSB's IC3 trainsets on long-distance traffic.

The IC4 technical specification required that up to 4 trainsets could run in multiple, i.e. a train formed of 16 cars, and this, together with the interior design layout, offered a significant increase in passenger traffic capacity over the fleet of IC3 trainsets so as to meet anticipated growth in passenger traffic.

In November 2002, DSB extended the original contract with AB for the additional supply of 23 x 2-car DMMU trainsets to be designated IC2, see Section 2.3 (URN 199). The IC2 trainsets were intended to operate primarily on the Odense to Svendborg route, but also to have the capability to operate with IC4 trainsets on long-distance services.

The GTA contract required AB to design, manufacture, and commission the two fleets of trainsets and to obtain type approval from the National Safety Authority (Trafikstyrelsen (TS)) for operation in passenger service. The first IC4 trainset should have been delivered by AB in April 2003 with the final (83$^{rd}$) IC4 trainset to be delivered in July 2005. For various well-known reasons this delivery programme was not achieved.

Between 2005 and 2008, four IC4 trainsets were shipped to Danmark for testing and passenger service. These trainsets were permitted to run only as single units and only in regional traffic (URN 015). Although limited passenger services commenced in 2007 in Jylland, these trainsets were never handed over to DSB and, following severe technical problems, operation of the trainsets was suspended by DSB in February 2008.

In May 2008, DSB issued an Ultimatum to AB to deliver 2 trainsets by August 2008 and a further 12 trainsets by May 2009, all 14 trainsets to be approved for operation as single units in National Traffic (NT), together with 1 trainset approved for multiple unit operation (MPTO). Failure to achieve these requirements would cause the contract to be terminated and appropriate compensation sought.

AB met the terms of the Ultimatum by delivering 14 trainsets designated NT++ (URN 019) and 1 trainset designated MPTO (URN 020/202) by 01 May 09. Conditional Type Approval for NT++ trainsets was obtained on 27 Jan 09 (URN 049 and, subsequently, URNs 043/052)and for the MPTO trainset on 04 May 09 (URN 050/051). Immediately following this, the two parties negotiated a Settlement Agreement, designated an Addendum, to modify the terms of the original contract (URN 198). This Addendum was signed on 19 May 09.

Under the terms of the Settlement Agreement, DSB recognised and accepted that the design configuration of the MPTO trainset, No. 5622, did not meet the original specified requirements, but agreed that the balance of 68 trainsets should be delivered by AB to the same design configuration and quality levels as represented by trainset 5622. Effectively it was agreed that trainset 5622 would act as a benchmark for acceptability of all further trainset deliveries. To meet this requirement, AB accepted that it would have to upgrade the fleet of 14 NT++ trainsets to the MPTO design configuration as part of the on-going delivery programme.

The delivery of each IC4 trainset comprises a number of stages of assembly, testing, and inspection in Italy, shipment by rail to Danmark, and commissioning and inspection in Danmark prior to Takeover of the trainset by DSB from AB. For the purposes of this Review, all stated delivery dates refer to the Takeover date.

The Settlement Agreement contained a new delivery schedule whereby trainset 5622 was considered to be the first delivery, the second trainset 5621 was to be delivered by 15 Nov 09, the third trainset 5623 was to be delivered by 28 Feb 10 and the remaining 80 trainsets, including the 14 NT++ trainsets to be upgraded, were to be delivered between 30 Apr 10 and 31 Jul 12 at an average production rate of 2.86 trainsets per month (URN 022).

In order to meet the Settlement Agreement schedule, AB significantly increased their production capacity so as to achieve coach production, train assembly, and shipment from three sites instead of two and coach production at another two sites as shown in the Table below:-

**Table 2.1.A - AB Train Production Facilities for IC4**

| Site | Location | Company | Activity |
|---|---|---|---|
| Pistoia | Italy | AB | Motor coach production<br>Train assembly<br>(trailer coaches from Reggio Calabria)<br>Testing, inspection, shipment |
| Verona | Italy | OFV | Motor coach production<br>Train assembly<br>(trailer coaches from Piacenza or Reggio Calabria)<br>Testing, inspection, shipment |
| Piacenza | Italy | SITAV | Motor coach production<br>Trailer coach production<br>Train assembly<br>Testing, inspection, shipment |
| Reggio Calabria | Italy | AB | Trailer coach production |
| Napoli | Italy | AB | Bogie production<br>TCMS |
| Århus | Danmark | AB | Commissioning |

Nevertheless, due to on-going concern as to AB's ability to deliver to the new schedule, a revised schedule was agreed on 16 Dec 10 whereby AB contracted DSB TM to undertake the 14 NT++ trainset upgrades at a leased facility in Randers, Danmark, thus allowing AB to focus on delivery of the other 69 trainsets from Italy to the original end date of July 2012 (URN 038).

In March 2011, AB and IC4PT commenced discussing a further Settlement Agreement for the IC4 and IC2 projects to cover various items (URN 178) including:-

- commercial issues related to on-going delivery of the trainsets;
- outstanding warranty claims;
- extension of the 50% discount on spares orders to end-2012;
- spares stock levels at Århus depot; and
- further development of TCMS under the upgrade contract.

These discussions are currently suspended, but will have to resume at some point in order to close-out the IC4/IC2 Contract.

In order to assess AB's ability to meet the revised schedule of 16 Dec 10 (URN 038), Atkins visited Pistoia, Italy, for meetings and interviews with AB representatives and visited the Pistoia train production and test facilities (URN 178). We also visited the AB commissioning facility at Augustenborggade, Århus, Danmark, and the DSB TM facility at Randers, Danmark, for meetings and interviews with AB and DSB TM representatives. We found that:-

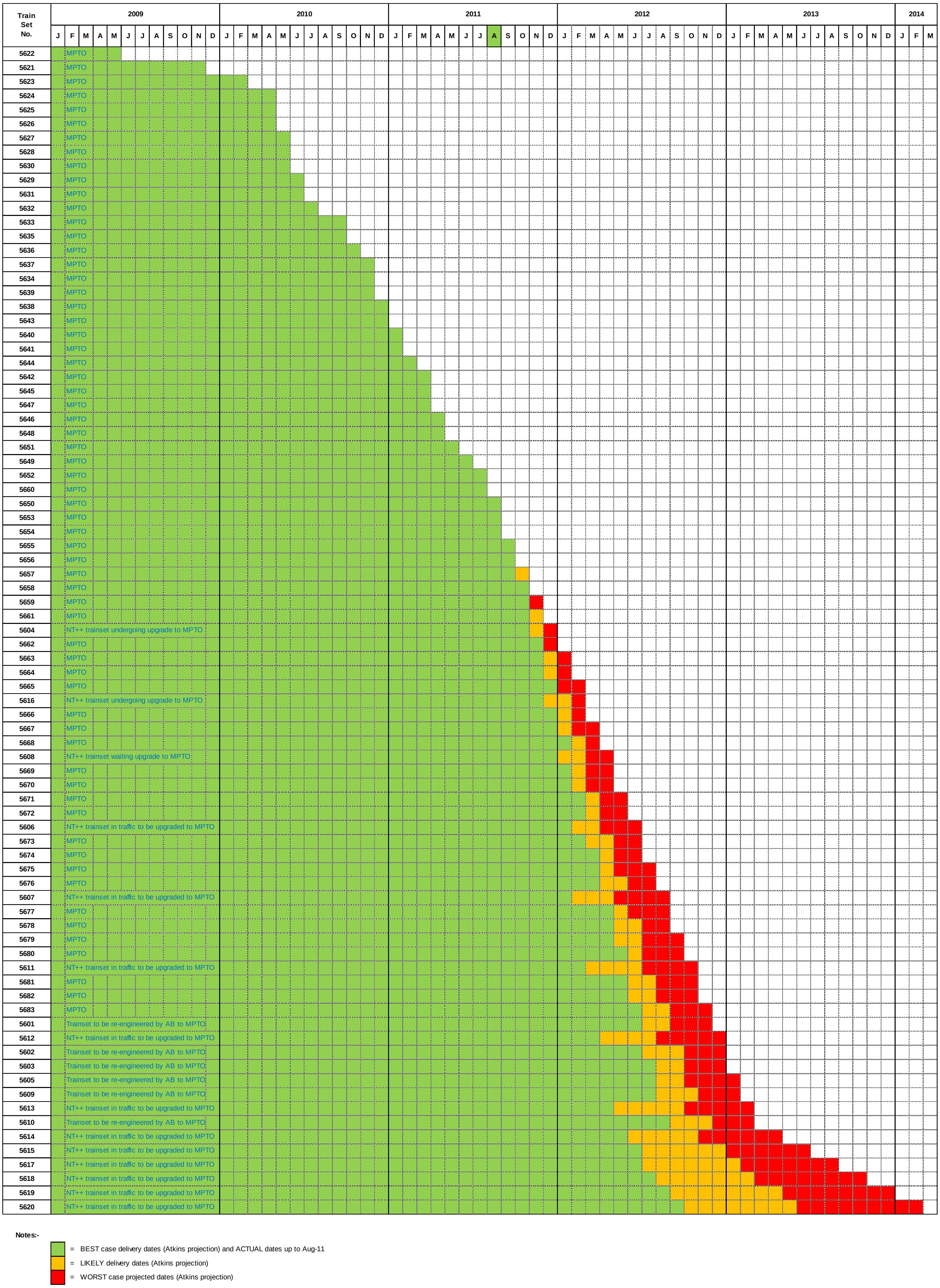
- All 332 coach bodies had been manufactured and were in various conditions of fit-out when production was frozen prior to the Settlement Agreement. All the bogies had also been manufactured. As a result, the coaches entered Long Term Storage (LTS) until production re-commenced. No special precautions were taken to protect equipment during LTS.
- The conditions in which LTS took place required that all coaches receive a pre-production check to establish the presence and condition of all components before being stripped of equipment prior to entering the current production line. Where applicable, the removed equipment is returned to original suppliers for re-work, testing, and re-delivery in as-new condition. These pre-production checks have been completed for all 332 coaches.
- Following pre-production checks, the stripped coaches undergo exterior repainting to the original specification and the exterior (and interior) surface treatments are subject to extended warranty, see Table 2.2.A.
- There have been delays to production in Italy due to materials supply shortages which have now been largely overcome (URNs 026/040).
- AB has delivered 35 trainsets up to 31 Aug 11. Discounting the first three trainsets (5622/5621/5623), this is 32 trainsets in 17 months representing an average production rate of 1.88 trainsets/month.
- Within the period up to 31 Jul 11 and ignoring initial production ramp-up at each site, the deliveries have averaged 0.56 trainsets/month from Pistoia, 0.82 trainsets/month from Verona, and 0.73 trainsets/month from Piacenza, providing a total of 2.11 trainset/month.
- As a result, AB is 11 trainsets behind the revised schedule as at 31 Aug 11, requiring the delivery of 34 trainsets in the next 11 months to achieve the end date of July 2012. This represents an average rate of delivery of 3.09 trainsets/month, although to end-July 2011 AB has achieved 3 trainsets per month in only 4 months (Apr 10, May 10, Nov 10, Mar 11, Aug 11).
- Each site has been further ramping up its production capability such that, theoretically, AB could now deliver up to 3.25 trainsets/month.
- Re-delivery of NT++ trains upgraded to MPTO are well behind schedule, see below.

The revised schedule of December 2010 (URN 038) required the first upgraded NT++ trainset to be re-delivered as an MPTO trainset in March 2011 and the final (14$^{th}$) trainset in June 2012. However, the first trainset (5604 handed over to AB by IC4PT on 30 Sep 10) and the second trainset (5616 handed over to AB by IC4PT on 03 Jan 11) are still in production having suffered severe delays for a variety of reasons. Trainset 5604 has been completed and is undergoing functional testing prior to Takeover by IC4PT while trainset 5608 has joined trainset 5616 in production.

DSB TM has proposed to increase its production manpower resource by 52% and its testing manpower resource by 100%, retaining the existing two production tracks but increasing the test tracks from the present one to two. On this basis, DSB TM has proposed an updated delivery schedule with the first upgraded NT++ trainset to be re-delivered in October 2011 and the final (14$^{th}$) trainset in September 2012 (URN 184). This requires the completion of 14 trainsets in 12 months, a rate of 1.17 trainsets/month. We consider this proposition to be optimistic.

Given the above, we have considered the overall delivery programme of 69 MPTO trainsets from Italy and 14 NT++ upgraded trainsets from Randers in order to project BEST, LIKELY, and WORST case scenarios. The results, shown in Fig. 2.1.B overleaf, are based upon the following assessments:-

- The BEST case projection assumes that AB delivers the remaining trainsets from Italy at a rate of 3.00 trainsets/month every month from August 2011 and that NT++ upgraded trainsets are re-delivered in accordance with DSB TM's proposed programme (URN 184).
- The LIKELY case projection assumes that AB delivers the remaining trainsets at a rate of 2.50 trainsets/month every month from August 2011 and that NT++ upgraded trainsets are re-delivered at a rate of 0.67 trainsets/month from November 2011.
- The WORST case projection assumes that AB continues to deliver the remaining trainsets at the rate achieved up to 31 Jul 1 of 1.81 trainsets/month and that NT++ upgraded trainsets are re-delivered at a rate of 0.50 trainsets/month from December 2011.




## Fig. 2.1.B - AB Train Delivery Programme Assessment

From this assessment, we conclude that it is possible, but unlikely, that AB will deliver the last trainset to DSB in July 2012 in accordance with the revised Settlement Agreement schedule of 16 Dec 10 (URN 038). However, given the track record to date for deliveries from Italy, the current difficulties that AB and DSB TM have in delivering the NT++ upgrade programme, and additional problems likely to be presented by re-engineering the completed trainsets in Italy that have not been taken over by DSB (Nos. 5601/5602/5603/5605/5609/5610), we consider that the following projected completion dates should be used by IC4PT for on-going planning of the project:-

**Table 2.1.C - AB Train Delivery Programme Assessment**

| Case | Completion Date |
|---|---|
| Settlement Agreement Revised Schedule (16 Dec 10) | July 2012 |
| BEST Case | September 2012 |
| LIKELY Case | May 2013 |
| WORST Case | February 2014 |

In addition to our assessment of AB's delivery programme, we have considered the percentage progress by analysing the following parameters:-

- the number of key post-Settlement production stages (H1, H2, H3, H4, shipment to Danmark, Takeover) that have been completed by AB as a percentage of the total required for the fleet of 83 trainsets;
- the number of trainsets taken over by DSB; and
- the value of stage payments made by DSB to AB as a percentage of the total contract value excluding lump sum payments.

In the latter case, the total contract value for IC4 under the Settlement Agreement is 3,771,834,000 DKK. This includes lump sum payments and stage payments for the trainsets, workshop equipment, spares, and training, but excludes tax. To date, AB has invoiced for 2,955,800,000 DKK of which 10,000,000 DKK is currently withheld by DSB (URN 214 and subsequent information). Thus the percentage payment to AB is now 78%. It should also be noted that all prepayments to AB are in the form of performance bonds from approved banks; DSB can withdraw from these if they consider AB to be in breach of contract.

However, the payments to AB are subject to a 50% rebate and 50% discounts on orders for spares up to a ceiling of 1 billion DKK and this is explained further in Section 4.1.3.

The apparent discrepancy in Table 2.1.C between percentage production and percentage payments to date has two reasons:-

- all lump sum payments are complete; and
- for the purposes of this Review we have assessed percentage production stages completed post-settlement whereas a considerable number of production stages had been completed and paid for prior to the Settlement Agreement.

The results of our progress assessment are presented in the following table:-

**Table 2.1.D - AB Train Delivery Progress Assessment**

| Measure | Percentage Completion |
|---|---|
| Post-settlement production stages completed | 71% |
| Trainsets taken over by DSB (35 out of 83) | 42% |
| Payments | 78% |

Our assessment of AB's capability to achieve the delivery programme does not take into account any possible impact on delivery of the published announcement on 23 Aug 11 that Finmeccanica may sell or close AB. The impact of such a decision is unpredictable at this stage and, until more is known about the developing situation, it should be assumed that Finmeccanica will require AB or any successor body to fulfil its current contractual obligations.

It should also be noted that one of the six completed trainsets that have remained in AB's hands throughout the project, 5609, is in Libya. Given the present situation in that country, this trainset may prove unrecoverable.

## 2.2. IC4 Train Delivery by the DSB IC4 Project Team (IC4PT)

Under the terms of the Settlement Agreement, DSB recognised and accepted that the design configuration of the MPTO trainset 5622 did not meet the original specified requirements, but agreed that the balance of 68 trainsets should be delivered by AB to this design configuration and quality levels and that the 14 NT++ trainsets should also be upgraded by AB to the MPTO design configuration. This change relieved AB of four important contractual obligations:-

- further engineering development of the trainsets to achieve conformance to the specified requirements for entry to inter-regional passenger traffic;
- obtaining type approvals from TS for developed design configurations;
- achievement of contractual reliability and life cycle cost targets; and
- warranty of the trainsets.

Among exceptions to the above are certain extended warranty obligations in the original contract that have survived the Settlement Agreement and AB is still obligated to supply spare parts. The extended warranty, as per the original contract, commences with delivery of each trainset and covers:-

**Table 2.2.A - AB Extended Warranty Obligations**

| Component | Warranty Period |
|---|---|
| Traction motors and mechanical traction equipment | 5 years |
| Axles | 6 years |
| Monobloc wheels | 6 years |
| Exterior and interior painting - corrosion | 12 years |
| Exterior and interior painting - colour and gloss | 6 years |
| Insulated windows | 5 years |
| Bogie frames 10 years | 10 years |
| Carbody | 15 years |

In return for this reduction in the supply requirements from AB, significant compensation was agreed in the form of discounts and this is considered further in Section 4.1.3.

The practical effect of these contractual changes is that IC4PT (within DSB) is now the train supplier with AB as a sub-contract train assembler and the IC4DT (within DSB) is the customer. This de facto situation is recognised by TS who has approved IC4PT's Safety Plan (URN 008) as a train supplier, not as a railway operator.

Thus, IC4PT now carries all the responsibilities for ensuring that the trainsets are engineered to a level of functionality, quality, and reliability and achieve type approval from TS so that the fleet can enter passenger traffic on long-distance Inter-City services as intended.

As a result, the project team has had to change since May 2009 from a procurement organisation responsible for managing the then main contractor, AB, to an engineering organisation capable of undertaking the necessary actions to complete the engineering and delivery of the fleet whilst continuing to manage the supply of trainsets from AB (URNs 005/145/188/189). A portion of the Settlement Agreement compensation was budgeted by DSB to cover these additional engineering costs, see Section 4.1.3.

From IC4PT's experience of operating and maintaining the 14 NT++ trainsets, they identified 750 technical issues which IC4PT considered had to be addressed for the IC4 to be considered acceptable for its intended purpose. These were analysed and prioritised down to 137 technical issues that should be addressed initially. In turn, these were aggregated into what became designated 50 'Known Issues' in 8 categories with a Team Leader assigned to each category (URN 023).

IC4PT planned to introduce engineering changes to the trainsets to address the 50 Known Issues (plus 440 TCMS issues) in two phases identified as Engineering Pack 1 (URN 021) and Engineering Pack 2 (see below). Further changes were envisaged in an as yet to be defined Engineering Pack 3. Subsequently, some of the changes planned for Packs 1 and 2 have been replaced by other modifications to address more urgent issues arising from the experience of running MPTO and MPTO P1 trainsets.

A key consideration for IC4PT was that, in MPTO design configuration as delivered by AB, only limited coupling capability was available and then only to a maximum of 2 trainsets instead of the 4 trainsets required for operation in long-distance services. This was more a question of lack of functional testing in 2, 3, and 4 trainset coupled configurations than of design, although there were also technical issues associated with operating in coupled train formations. IC4PT therefore decided that the Train Control Management System (TCMS) should be subjected to a separate upgrade process and, following a competitive tendering process, a contract was awarded in November 2009 to AB to the value of 210,000,000 DKK, but now subject to a 50% discount under the Settlement Agreement, to provide the following:-

- Software Package 1 to include 2 trainset coupling configuration
- Software Package 2 to include 3 trainset coupling configuration
- Software maintenance for 5 years from completion of the warranty period
- Option to upgrade IC2 TCMS to a level comparable with IC4
- Option for further development of TCMS

The TCMS upgrade programme is being conducted in parallel with the engineering changes encompassed in Pack 1 and Pack 2 and IC4PT has aligned delivery of the two workstreams so that type approval and implementation is combined, Pack 1 Engineering with Package 1 TCMS and Pack 2 Engineering with Package 2 TCMS (URNs 028/107).

Up to August 2011, IC4PT had fitted Pack 1 Engineering to 18 MPTO trainsets of which 12 entered traffic and 6 remained in development testing and simulation running, but has now prioritised fitting a partial Pack 2, designated Driftpakke 2 or Pack 2D, to all 18 MPTO P1 trainsets, primarily to rectify climatic problems experienced during the 2010/2011 winter period (URNs 265/266/267). Fitting Pack 2D has commenced on trainsets 5630 and 5646 and is scheduled to be completed by end-November 2011. In order to facilitate this programme, IC4PT has temporarily suspended modifications to MPTO trainsets delivered by AB and subsequent running simulation in order to utilise fully the 2 available tracks in Århus Depot. Trainsets fitted with Pack 2D will have to re-enter the production programme at some stage in order to receive the remaining Pack 2 modifications which, for the purposes of this Report, we have designated Pack 2A. IC4PT has also decided to withdraw all NT++ trainsets from passenger service by December 2011 to await upgrade to MPTO design configuration by AB and then Pack 1+2 modification by IC4PT.

Until recently, it was IC4PT's intention to develop an Engineering Pack 3 aligned with a Package 3 TCMS upgrade. This would have completed IC4PT's programme of engineering and TCMS changes to deliver 4-set coupled multiple operation. However, a TCMS Package 3 would have to be negotiated with AB at additional cost under the option for "further development" in the TCMS Upgrade contract, while engineering changes are now being planned on a staged basis rather than as a single pack of modifications. IC4PT has only recently commenced planning modifications to follow the implementation of Pack 2 and those changes that are under consideration have been divided into two stages designated Pack 2.1 and Pack 2.2, with each modification having to be justified by a business case.

We consider that the current approach to further development of the trainsets is sensible but with two recommendations:-

- The timescale to implement TCMS Package 3, should its development proceed, should not be linked to the programme of other engineering changes. The TCMS changes are to software only and once developed, tested, verified, and approved, can be implemented quickly across the whole fleet.
- The programme of engineering changes has to be focused on reliability improvement, see Section 5 of this Report, and developed and implemented more quickly than the current approach will allow.

Essentially, Packs 2.1 and 2.2, or their equivalents, together with further engineering changes to be brought in by the IC4PT, should be implemented within the same timeframe as is currently planned for the fitments of Pack 2 to the trainsets. The current situation with the stages of production by IC4PT are summarised in the following Table:-

**Table 2.2.B - IC4PT Modifications to IC4 Trainsets**

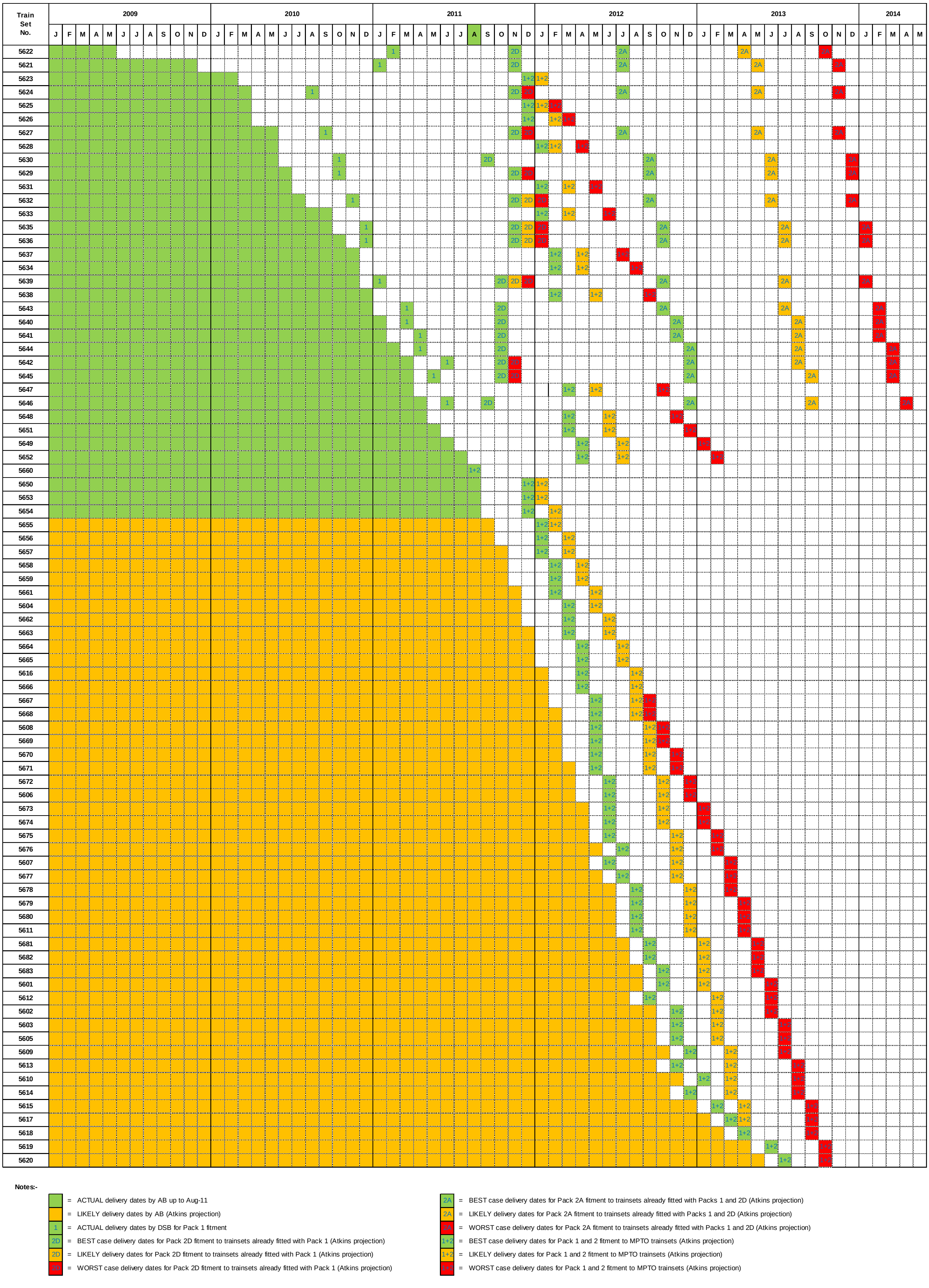
| Pack | Category | Status as at 31 Aug 11 |
|---|---|---|
| Pack 1 | Engineering | Fitment completed for 18 MPTO trainsets |
| Package 1 | TCMS Upgrade | Fitment completed for 18 MPTO trainsets |
| Pack 2D | Engineering | To be fitted to 18 MPTO P1 trainsets in Oct/Nov 11 |
| Pack 2A | Engineering | To be fitted to 18 MPTO P2D trainsets at some stage |
| Pack 1+2 | Engineering | Fitted to 2 MPTO trainsets for type approval tests |
| Pack 1+2 | Engineering | To be fitted to all MPTO trainsets from Dec 11 |
| Package 2 | TCMS Upgrade | To be fitted to all trainsets from Oct 11 |
| Pack 2.1 | Engineering | In development |
| Pack 2.2 | Engineering | In development |
| Pack 2.3 | Engineering | To be considered |
| Further Packs | Engineering | To be considered |
| Package 3 | TCMS Upgrade | To be considered |

Conditional type approval for implementation of Pack 1, including the TCMS Package 1 changes, was obtained on 04 Nov 10 which allowed MPTO P1 trainsets to commence operation in passenger service in 2-trainset coupled configuration from January 2011 (URN 042). Coupled operation was implemented initially, but was then suspended due to problems with the coupling and uncoupling system, see Section 3.1.3. For a period, MPTO P1 trainsets operated in traffic as single units, but multiple 2-coupled operation re-commenced recently.

The first 5 MPTO P1 trainsets entered traffic in January 2011 and, since then, a total of 18 MPTO trainsets have been so modified. Pack 1 fitments have taken 10 working days to implement and 2 tracks within Århus Depot were allocated for the work. During August 2011, trainsets 5638 and 5660 were fitted with the combined Pack 1+2 in order to enter a test programme aimed at obtaining Type Approval in October or November 2011.

IC4PT is considering plans for ramping up production at Randers and other potential sites, including modification fitment and testing, in conjunction with vacating the preset 2 tracks in the Århus Depot so that this facility can focus entirely on maintenance activities, and expects to achieve the same output for combined Pack 1+2 fitments as the previous Pack 1 fitments giving a production rate of 4 trainsets/month. However, at this production rate the delivered MPTO trainsets will have to be stored by IC4PT for periods of 4 to 5 months each while waiting for Pack 1+2 fitment before they can enter passenger service and we therefore conclude that the production rate should be increased to at least 6 trainsets/month.

We have reviewed IC4PT's progress with the fitments of modifications to date and their plans to fit Pack 2D and the combined Pack 1+2 and, against this background, we have assessed their resource levels, capabilities, and competences. From this review, and using the LIKELY delivery of MPTO trainsets by AB shown in Fig. 2.1B as a starting point, we have projected BEST, LIKELY, and WORST CASE scenarios for the delivery by IC4PT of modified trainsets to traffic with the results shown in Fig. 2.2.C overleaf:-



### Fig. 2.2.C - IC4PT Train Delivery Programme Assessment

Fig. 2.2.C is based upon the following assumptions:-

- The BEST case projection assumes that IC4PT delivers the Pack 2D programme by end-November 2011 as scheduled and the subsequent Pack 1+2 at a rate of 6 trainsets/month.
- The LIKELY case projection assumes that IC4PT delivers the Pack 2D programme by end-December 2011 and the subsequent Pack 1+2 at a rate of 4 trainsets/month.
- The WORST case projection assumes that IC4PT delivers the Pack 2D programme by end-January 2012 and the subsequent Pack 1+2 at a rate of 3 trainsets/month.

From this assessment, we conclude the following:-

### Table 2.2.D - DSB IC4PT Train Delivery Programme Assessment

| Pack 1+2 Delivery | Completion Date |
|---|---|
| BEST Case | July 2013 |
| LIKELY Case | September 2013 |
| WORST Case | April 2014 |

We find that the overall delivery programme for modified trainsets by IC4PT is relatively insensitive to variations in AB's delivery programme. If AB should meet their BEST case projection, then trainsets will be standing in Århus for longer periods awaiting Pack 1+2 fitment by IC4PT. If the AB programme should slip to their LIKELY projected dates, then the IC4PT programme will be as shown in Fig. 2.2.B. If the AB programme should slip to their WORST case projection then IC4PT's BEST case projection would be adversely affected but their LIKELY case projection would only be affected for the final 5 to 6 trainsets.

The potential impact on IC4's operating performance of the Pack 2D and Pack 1+2 modification programme together with other modifications and associated timescale projections is considered in Section 4.2.

In the course of our review, we have established the status of all IC4 trainsets as at 31 Aug 11 as shown in Fig. 2.2.F overleaf. In summary, the disposition of trainsets taken over by IC4PT is:-

### Table 2.2.E - Disposition of IC4 Trainsets Following Takeover

| Configuration | Activity as at 31 Jul 11 | Trainsets # |
|---|---|---|
| NT++ | In passenger service | 10 |
| NT++ | Waiting repair | 1 |
| NT++ | Waiting for upgrade to MPTO | 0 |
| NT++ | Undergoing upgrade to MPTO | 3 |
| | **Total** | **14** |
| MPTO P1 | In passenger service | 10 |
| MPTO P1 | In testing or simulation | 6 |
| MPTO | In testing or simulation | 4 |
| MPTO | Undergoing Pack 1+2 fitment | 2 |
| MPTO | Waiting Pack 1+2 fitment | 13 |
| | **Total** | **35** |

| Train Set No. | Takeover Date in MPTO Design Configuration | | | | | Design Configuration | | | | | | Production | | | | | | | | | | | | | Operation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contract Schedule 07-Dec-00 | Settlement Schedule 15-May-09 | Revised Schedule 16-Dec-10 | Actual as at 31-Jul-11 | *Likely as at 31-Jul-11* | NT++ | PTO | MPTO | MPTO Pack 1 | MPTO Pack 2 | MPTO Pack 3 | LTS | HP1 | HP2 | HP3 | HP4 | AB in IT | Ship to DK | AB in DK | NT++ Upgrade | Take Over as MPTO | DSB Pack 1 | DSB Pack 2 | DSB Pack 3 | Simulation or Testing | Waiting Repair Pack 1 Fitment or NT++ Upgrade | In Pack 1 Fitment or NT++ Upgrade | Traffic |
| 5601 | 15-Apr-03 | 30-Jun-12 | 30-Jun-12 | AB | *30-Sep-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5602 | 15-Jun-03 | 30-Jun-12 | 30-Jun-12 | AB | *30-Sep-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5603 | 15-Jul-03 | 30-Jun-12 | 30-Jun-12 | AB | *31-Oct-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5604 | 15-Oct-03 | 31-Jan-11 | 31-Mar-11 | NT++ | *30-Nov-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5605 | 15-Oct-03 | 31-Jul-12 | 31-Jul-12 | AB | *31-Oct-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5606 | 15-Nov-03 | 28-Feb-11 | 30-Jun-11 | NT++ | *31-Mar-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5607 | 15-Nov-03 | 31-Mar-11 | 31-Jul-11 | NT++ | *30-Apr-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5608 | 15-Nov-03 | 30-Apr-11 | 31-Aug-11 | NT++ | *28-Feb-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5609 | 15-Dec-03 | 31-Jul-12 | 31-Jul-12 | AB | *31-Oct-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5610 | 15-Dec-03 | 31-Jul-12 | 31-Jul-12 | AB | *30-Nov-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5611 | 15-Dec-03 | 31-May-11 | 30-Sep-11 | NT++ | *30-Jun-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5612 | 15-Dec-03 | 30-Jun-11 | 31-Oct-11 | NT++ | *31-Jul-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5613 | 15-Jan-04 | 31-Jul-11 | 30-Nov-11 | NT++ | *30-Sep-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5614 | 15-Jan-04 | 30-Sep-11 | 31-Dec-11 | NT++ | *31-Oct-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5615 | 15-Jan-04 | 31-Oct-11 | 31-Jan-12 | NT++ | *31-Dec-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5616 | 15-Jan-04 | 30-Nov-11 | 29-Feb-12 | NT++ | *31-Jan-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5617 | 15-Feb-04 | 31-Dec-11 | 31-Mar-12 | NT++ | *31-Jan-13* | | | | | | | | | | | | | | | | | | | | | | | |
| 5618 | 15-Feb-04 | 31-Jan-12 | 30-Apr-12 | NT++ | *28-Feb-13* | | | | | | | | | | | | | | | | | | | | | | | |
| 5619 | 15-Feb-04 | 29-Feb-12 | 31-May-12 | NT++ | *30-Apr-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5620 | 15-Feb-04 | 31-Mar-12 | 30-Jun-12 | NT++ | *31-May-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5621 | 15-Mar-04 | 15-Nov-09 | 15-Nov-09 | 15-Nov-09 | 15-Nov-09 | | | | | | | | | | | | | | | | | | | | | | | |
| 5622 | 15-Mar-04 | 01-May-09 | 01-May-09 | 01-May-09 | 01-May-09 | | | | | | | | | | | | | | | | | | | | | | | |
| 5623 | 15-Mar-04 | 28-Feb-10 | 28-Feb-10 | 28-Feb-10 | 28-Feb-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5624 | 15-Mar-04 | 30-Apr-10 | 30-Apr-10 | 23-Apr-10 | 23-Apr-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5625 | 15-Apr-04 | 30-Apr-10 | 30-Apr-10 | 29-Apr-10 | 29-Apr-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5626 | 15-Apr-04 | 30-Apr-10 | 30-Apr-10 | 29-Apr-10 | 29-Apr-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5627 | 15-Apr-04 | 31-May-10 | 31-May-10 | 26-May-10 | 26-May-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5628 | 15-Apr-04 | 31-May-10 | 31-May-10 | 31-May-10 | 31-May-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5629 | 15-May-04 | 31-May-10 | 31-May-10 | 30-Jun-10 | 30-Jun-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5630 | 15-May-04 | 30-Jun-10 | 30-Jun-10 | 31-May-10 | 31-May-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5631 | 15-May-04 | 30-Jun-10 | 31-Jul-10 | 30-Jun-10 | 30-Jun-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5632 | 15-May-04 | 30-Jun-10 | 31-Jul-10 | 31-Jul-10 | 31-Jul-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5633 | 15-Jun-04 | 31-Jul-10 | 31-Aug-10 | 03-Sep-10 | 03-Sep-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5634 | 15-Jun-04 | 31-Jul-10 | 30-Sep-10 | 10-Nov-10 | 10-Nov-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5635 | 15-Jun-04 | 31-Jul-10 | 30-Sep-10 | 22-Sep-10 | 22-Sep-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5636 | 15-Jun-04 | 31-Aug-10 | 30-Sep-10 | 29-Oct-10 | 29-Oct-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5637 | 15-Jul-04 | 30-Sep-10 | 31-Oct-10 | 15-Oct-10 | 15-Oct-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5638 | 15-Jul-04 | 30-Sep-10 | 31-Oct-10 | 08-Dec-10 | 08-Dec-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5639 | 15-Jul-04 | 30-Sep-10 | 31-Oct-10 | 30-Nov-10 | 30-Nov-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5640 | 15-Jul-04 | 31-Oct-10 | 30-Nov-10 | 21-Jan-11 | 21-Jan-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5641 | 15-Sep-04 | 31-Oct-10 | 30-Nov-10 | 28-Jan-11 | 28-Jan-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5642 | 15-Sep-04 | 31-Oct-10 | 30-Nov-10 | 04-Mar-11 | 04-Mar-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5643 | 15-Sep-04 | 30-Nov-10 | 31-Dec-10 | 31-Dec-10 | 31-Dec-10 | | | | | | | | | | | | | | | | | | | | | | | |
| 5644 | 15-Sep-04 | 30-Nov-10 | 31-Dec-10 | 22-Feb-11 | 22-Feb-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5645 | 15-Oct-04 | 30-Nov-10 | 31-Dec-10 | 08-Mar-11 | 08-Mar-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5646 | 15-Oct-04 | 31-Dec-10 | 31-Jan-11 | 29-Apr-11 | 29-Apr-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5647 | 15-Oct-04 | 31-Dec-10 | 31-Jan-11 | 30-Mar-11 | 30-Mar-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5648 | 15-Oct-04 | 31-Dec-10 | 31-Jan-11 | 15-Apr-11 | 15-Apr-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5649 | 15-Nov-04 | 31-Jan-11 | 28-Feb-11 | 10-Jun-11 | 10-Jun-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5650 | 15-Nov-04 | 31-Jan-11 | 28-Feb-11 | | 31-Aug-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5651 | 15-Nov-04 | 28-Feb-11 | 28-Feb-11 | 31-May-11 | 31-May-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5652 | 15-Nov-04 | 28-Feb-11 | 31-Mar-11 | 27-Jul-11 | 27-Jul-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5653 | 15-Dec-04 | 31-Mar-11 | 31-Mar-11 | | 31-Aug-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5654 | 15-Dec-04 | 31-Mar-11 | 30-Apr-11 | | 31-Aug-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5655 | 15-Dec-04 | 30-Apr-11 | 30-Apr-11 | | *30-Sep-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5656 | 15-Dec-04 | 30-Apr-11 | 30-Apr-11 | | *30-Sep-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5657 | 15-Jan-05 | 31-May-11 | 31-May-11 | | *30-Oct-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5658 | 15-Jan-05 | 31-May-11 | 31-May-11 | | *30-Oct-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5659 | 15-Jan-05 | 30-Jun-11 | 30-Jun-11 | | *30-Oct-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5660 | 15-Jan-05 | 30-Jun-11 | 30-Jun-11 | 06-Jul-11 | 06-Jul-11 | | | | | | | | | | | | | | | | | | | | | | | |
| 5661 | 15-Feb-05 | 31-Jul-11 | 30-Jun-11 | | *30-Nov-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5662 | 15-Feb-05 | 31-Jul-11 | 31-Jul-11 | | *30-Nov-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5663 | 15-Feb-05 | 31-Aug-11 | 31-Jul-11 | | *31-Dec-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5664 | 15-Feb-05 | 30-Sep-11 | 31-Aug-11 | | *31-Dec-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5665 | 15-Mar-05 | 30-Sep-11 | 30-Sep-11 | | *31-Dec-11* | | | | | | | | | | | | | | | | | | | | | | | |
| 5666 | 15-Mar-05 | 31-Oct-11 | 30-Sep-11 | | *31-Jan-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5667 | 15-Mar-05 | 31-Oct-11 | 31-Oct-11 | | *31-Jan-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5668 | 15-Mar-05 | 30-Nov-11 | 31-Oct-11 | | *28-Feb-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5669 | 15-Apr-05 | 30-Nov-11 | 30-Nov-11 | | *28-Feb-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5670 | 15-Apr-05 | 31-Dec-11 | 30-Nov-11 | | *28-Feb-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5671 | 15-Apr-05 | 31-Dec-11 | 31-Dec-11 | | *31-Mar-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5672 | 15-Apr-05 | 31-Jan-12 | 31-Dec-11 | | *31-Mar-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5673 | 15-May-05 | 31-Jan-12 | 31-Jan-12 | | *30-Apr-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5674 | 15-May-05 | 29-Feb-12 | 31-Jan-12 | | *30-Apr-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5675 | 15-May-05 | 29-Feb-12 | 29-Feb-12 | | *30-Apr-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5676 | 15-May-05 | 31-Mar-12 | 29-Feb-12 | | *31-May-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5677 | 15-Jun-05 | 31-Mar-12 | 31-Mar-12 | | *31-May-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5678 | 15-Jun-05 | 30-Apr-12 | 31-Mar-12 | | *30-Jun-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5679 | 15-Jun-05 | 30-Apr-12 | 30-Apr-12 | | *30-Jun-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5680 | 15-Jun-05 | 30-Apr-12 | 30-Apr-12 | | *30-Jun-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5681 | 15-Jul-05 | 31-May-12 | 31-May-12 | | *31-Jul-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5682 | 15-Jul-05 | 31-May-12 | 31-May-12 | | *31-Jul-12* | | | | | | | | | | | | | | | | | | | | | | | |
| 5683 | 15-Jul-05 | 31-May-12 | 31-May-12 | | *30-Aug-12* | | | | | | | | | | | | | | | | | | | | | | | |

**Notes:-**

= stage completed

= stage not applicable

## Fig. 2.2.F - IC4 Train Status as at 31 Aug 11

As for the AB delivery programme, we have assessed the percentage progress of IC4PT's production and delivery programme with the following results:-

**Table 2.2.G - DSB IC4PT Train Delivery Progress Assessment**

| Measure | Percentage Completion |
|---|---|
| Pack 1 / 2 / 3 production stages completed | 8% |
| Trainsets authorised for passenger service in MPTO P1 configuration (2 coupled trainsets) (16 out of 83) | 19% |
| Trainsets authorised for passenger service in MPTO P2 configuration (3 coupled trainsets) | 0% |

This demonstrates vividly that the IC4PT will have to undertake a considerable engineering effort over the next 3 to 5 years to deliver the fully-modified fleet of IC4 trainsets while at the same time providing substantial technical support to the IC4DT.

## 2.3. IC2 Train Delivery by AB

In November 2002, DSB extended the original IC4 contract for the additional supply by AB of 23 x 2-car DMMU trainsets to be designated IC2 (URN 199). The trainsets were intended to operate primarily on the Odense to Svendborg route, but also to have the capability to operate with IC4 trainsets on long-distance services.

As was the case for IC4, this contract extension required AB to design, manufacture, and commission the IC2 fleet of trainsets and to obtain type approval from the National Safety Authority (Trafikstyrelsen or TS) for operation in passenger service. The first IC2 trainset should have been delivered in December 2004 and the 23rd IC2 trainset in November 2005. This delivery programme was not achieved.

Following the IC4 Settlement Agreement, DSB and AB further agreed to reach a similar contractual arrangement for IC2 based upon the principles of the IC4 Contract Addendum of 19 May 09. The IC2 Contract Addendum was signed on 01 Jul 09 (URN 200).

The IC2 Settlement Agreement contained a new schedule for delivery of the trainsets with the first trainset to be delivered in June 2011, the 2nd trainset in October 2011, and then at a rate of 2 trainsets/month up to the 23rd trainset in September 2012 (URN 227). The trainsets are to be delivered in MPTO design configuration comparable to the IC4 production by AB.

As for IC4 and in order to meet the Settlement Agreement schedule, AB altered their production capacity by employing a sub-contractor, Rustici, located at Montale near Pistoia as shown in the Table below:-

**Table 2.3.A - AB Train Production Facilities for IC2**

| Site | Location | Company | Activity |
|---|---|---|---|
| Montale | Italy | Rustici | Motor coach production<br>Trailer coaches production<br>Train assembly |
| Pistoia | Italy | AB | Motor coach production (type train only)<br>Trailer coach production (type train only)<br>Train assembly (type train only)<br>Testing, inspection, shipment |
| Napoli | Italy | AB | Bogie production<br>TCMS |
| Århus | Danmark | AB | Commissioning |

From our visits to Pistoia, Italy, the AB commissioning facility at Århus, Danmark, and subsequent information (URN 262) we found that:-

- All 46 coach bodies had been manufactured and were in various states of fit-out when production was frozen prior to the Settlement Agreement. All the bogies had also been manufactured. As a result, the coaches entered Long Term Storage (LTS) until production re-commenced.
- LTS required that all coaches receive a pre-production check before being stripped of equipment, much of which is returned to the original suppliers for re-work and testing for re-delivery in as-new condition, prior to entering the current production line. These pre-production checks have been completed for all 46 coaches.
- Trainsets IC2-01 to IC2-04 have been completed so far as production stages are concerned with IC2-01 and IC2-02 undergoing type tests in Italy, IC2-03 in Germany for track tests to demonstrate compliance to UIC518, and IC2-04 in Danmark for track tests to obtain type approval to operate at speeds up to 160 km/h. On completion of the tests, IC2-04 is to return to Italy for completion and re-delivery.
- IC2 trainset testing in AB's facility in Pistoia (after trainset IC2-04) will be undertaken by Rustici personnel working in facilities separate from those used for IC4 production and testing.

As for IC4, we have considered the delivery programme of 23 MPTO trainsets in order to project BEST, LIKELY, and WORST case scenarios. The results are shown in Fig. 2.3.B below and are based upon the following assessments:-

- The BEST case projection assumes that AB delivers the trainsets from Italy at the rate required by the Settlement Agreement schedule of 2 trainsets/month following an initial ramp-up, but commencing from December 2011 instead of June 2011. This is based upon an expectation that MPTO Type Approval will be obtained by November 2011 following completion of track tests in Germany and Danmark and type tests in Italy.
- The LIKELY case projection assumes that AB delivers the trainsets at a rate of 1.50 trainsets/month following an initial ramp-up from January 2012.
- The WORST case projection assumes that AB delivers the trainsets at a rate of 1.00 trainsets/month throughout from January 2012.

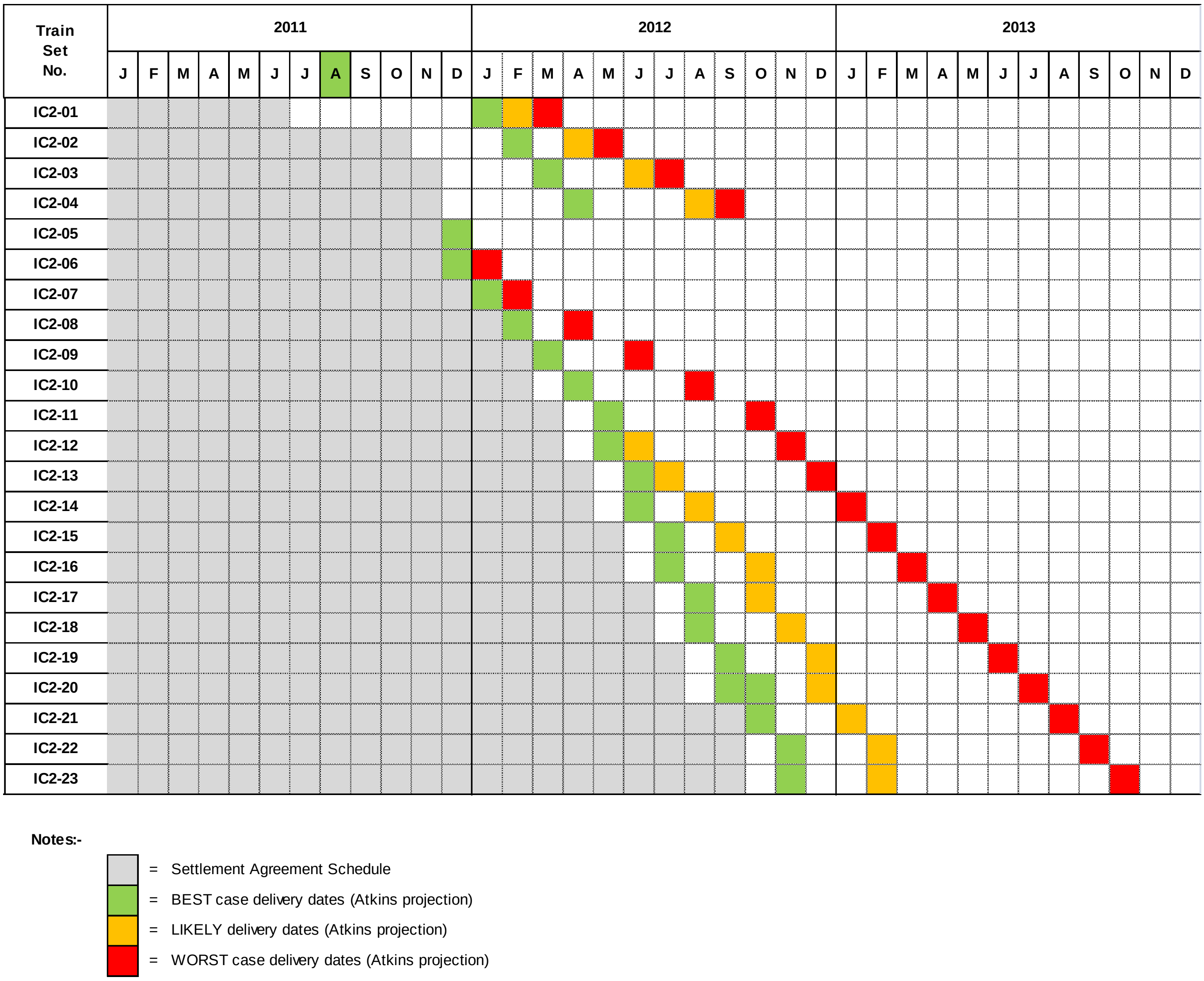



**Fig. 2.3.B - AB Train Delivery Programme Assessment**

From this assessment, we conclude that it is likely that AB will deliver the last trainset to DSB in February 2013 and that the following projected completion dates should be used by IC4PT for on-going planning of the project:-

**Table 2.3.C - AB Train Delivery Programme Assessment**

| Case | IC2 Completion Date | IC4 Completion Date |
|---|---|---|
| Settlement Agreement | September 2012 | July 2012 |
| BEST Case | November 2012 | September 2012 |
| LIKELY Case | February 2013 | May 2013 |
| WORST Case | October 2013 | February 2014 |

We have included the IC4 scheduled and projected dates in the table above to show that, except in the BEST case IC4 scenario, IC2 delivery will be completed before IC4.

Our assessment of AB's capability to achieve the delivery programme does not take into account any possible impact on delivery of the published announcement on 23 Aug 11 that Finmeccanica may sell or close AB. The impact of such a decision is unpredictable at this stage and, until more is known about the developing situation, it should be assumed that Finmeccanica will require AB or any successor body to fulfil its current contractual obligations.

In addition to our assessment of AB's delivery programme, we have considered the percentage progress by analysing the following parameters:-

- the number of key production stages (H1, H2, H3, H4, shipment to Danmark, Takeover) that have been completed as a percentage of the total required for the fleet of 23 trainsets;
- the number of trainsets taken over by DSB; and
- the value of stage payments made by DSB to AB as a percentage of the total contract value excluding lump sum payments.

In the latter case, the total contract value for IC2 under the Settlement Agreement is 680,701,000 DKK. This includes lump sum payments and stage payments for the trainsets, workshop equipment, spares, and training, but excludes tax. It is subject to a 50% rebate and there are also 50% discounts on orders for spares. To date, AB has invoiced for 408,300,000 DKK with no withholdings (URN 215 and subsequent information). Thus the percentage payment to AB is now 60%. The apparent discrepancy between percentage production and percentage payments to date has two reasons:- i) lump sums paid between 2002 and 2005 and ii) for the purposes of this Review we have assessed percentage production stages completed post-settlement whereas a considerable number of production stages had been completed and paid for prior to the Settlement Agreement.

Like IC4, all prepayments to AB on the IC2 project are in the form of irrevocable performance bonds.

The results are presented in the following table:-

**Table 2.3.D - AB Train Delivery Progress Assessment**

| Measure | Percentage Completion |
|---|---|
| Production stages completed | 30% |
| Trainsets taken over by DSB (0 out of 23) | 0% |
| Payments | 60% |

## 2.4. IC2 Train Delivery by IC4PT

As for IC4, under the terms of the Settlement Agreement DSB accepted that the 23 IC2 trainsets should be delivered by AB to the MPTO design configuration and quality levels generally represented by IC4 trainset 5622 but recognising that the trainset formation is different as follows:-

- each 4-car IC4 trainset comprises:-

  M1 car driving motor coach
  T2 car non-driving trailer coach with low floor section
  T3 car non-driving trailer coach
  M2 car driving motor coach

- each 2-car IC2 trainset comprises:-

  M1 car driving motor coach
  T2 car driving trailer coach with low floor section

Thus the T2 car in IC2 is generally similar to the IC4 T2 car except that it has a driving cab fitted.

IC4PT therefore carry all the responsibilities for ensuring that both the IC4 and IC2 fleets are engineered to a level of functionality, quality, and reliability and achieve type approval from TS so that the fleet can enter long distance Inter-City and inter-regional traffic as intended.

No IC2 trainsets have yet been taken over by IC4PT and, therefore, no IC2 trainsets are available to IC4PT for modification. The trainsets will be shipped by rail to Danmark as per IC4, arriving at Århus Depot and then moving to Augustenborggade, Århus, for commissioning by AB. The location for modified fitments is yet to be decided.

DSB propose to base the IC2 fleet at a Maintenance Depot in Fredericia which currently houses 2-car regional DMUs, but modifications to the Depot will be required to add lifting and coach roof access facilities designed specifically to cater for IC2. It is intended to undertake simulation running out of Fredericia, but modifications comparable to the IC4 Pack 1+2+3 fitments will be carried out at Randers or another suitable location.

It should also be considered whether Fredericia will be the most suitable location for simulation running as access to the Odense to Svendborg route may be limited. It should be further considered whether Fredericia is the appropriate long-term location for IC2 maintenance.

Based on the experience gained from IC4, the IC4PT has been considering what IC4 modifications to fit to IC2 and also alternative strategies for fitment of these modifications prior to introduction to passenger traffic (URN 262) including:-

- run in simulation (i.e. not in passenger service) and then modify after this period of operational experience; or
- modify and then run in simulation.

These considerations are on-going, but the likely strategy is to run in simulation and then modify the trainsets.

IC4PT had prepared a preliminary plan for fitment of modifications to IC2 trains, including TCMS upgrades, in terms of both timescale and content, but this was based on AB delivering IC2 trainsets in accordance with the Settlement Agreement dates (URNs 262/263/264). Given the present situation, we have not projected BEST, LIKELY, and WORST case scenarios for delivery of IC2 trainsets by IC4PT to IC4DT, but the present status of all IC2 trainsets is shown in Fig. 2.4.A below:-

| Train Set No. | Takeover Date in MPTO Design Configuration | | | | Design Configuration | | | | Production | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Contract Schedule Nov-02 | Settlement Schedule 26-Jun-09 | Actual as at 31-Jul-11 | *Likely as at 31-Jul-11* | MPTO | MPTO Pack 1 | MPTO Pack 2 | MPTO Pack 3 | LTS | HP1 | HP2 | HP3 | HP4 | AB in IT | Ship to DK | AB in DK | Take Over as MPTO | DSB Pack 1 | DSB Pack 2 | DSB Pack 3 |
| IC2-01 | 06-Dec-04 | 30-Jun-11 | | | | | | | | | | | | | | | | | | |
| IC2-02 | 20-Feb-05 | 31-Oct-11 | | | | | | | | | | | | | | | | | | |
| IC2-03 | 20-Mar-05 | 30-Nov-11 | | | | | | | | | | | | | | | | | | |
| IC2-04 | 20-Mar-05 | 30-Nov-11 | | | | | | | | | | | | | | | | | | |
| IC2-05 | 20-Apr-05 | 31-Dec-11 | | | | | | | | | | | | | | | | | | |
| IC2-06 | 20-Apr-05 | 31-Dec-11 | | | | | | | | | | | | | | | | | | |
| IC2-07 | 20-Apr-05 | 31-Jan-12 | | | | | | | | | | | | | | | | | | |
| IC2-08 | 20-May-05 | 31-Jan-12 | | | | | | | | | | | | | | | | | | |
| IC2-09 | 20-May-05 | 29-Feb-12 | | | | | | | | | | | | | | | | | | |
| IC2-10 | 20-Jun-05 | 29-Feb-12 | | | | | | | | | | | | | | | | | | |
| IC2-11 | 20-Jun-05 | 31-Mar-12 | | | | | | | | | | | | | | | | | | |
| IC2-12 | 20-Jun-05 | 31-Mar-12 | | | | | | | | | | | | | | | | | | |
| IC2-13 | 20-Jul-05 | 30-Apr-12 | | | | | | | | | | | | | | | | | | |
| IC2-14 | 20-Jul-05 | 30-Apr-12 | | | | | | | | | | | | | | | | | | |
| IC2-15 | 20-Sep-05 | 31-May-12 | | | | | | | | | | | | | | | | | | |
| IC2-16 | 20-Sep-05 | 31-May-12 | | | | | | | | | | | | | | | | | | |
| IC2-17 | 20-Sep-05 | 30-Jun-12 | | | | | | | | | | | | | | | | | | |
| IC2-18 | 20-Oct-05 | 30-Jun-12 | | | | | | | | | | | | | | | | | | |
| IC2-19 | 20-Oct-05 | 31-Jul-12 | | | | | | | | | | | | | | | | | | |
| IC2-20 | 20-Nov-05 | 31-Jul-12 | | | | | | | | | | | | | | | | | | |
| IC2-21 | 20-Nov-05 | 30-Sep-12 | | | | | | | | | | | | | | | | | | |
| IC2-22 | 20-Nov-05 | 30-Sep-12 | | | | | | | | | | | | | | | | | | |
| IC2-23 | 20-Nov-05 | 30-Sep-12 | | | | | | | | | | | | | | | | | | |

**Fig. 2.4.A - IC2 Train Status**

## 2.5. Delivery Quality

### 2.5.1. Concerns

From the outset of deliveries by AB, DSB has had serious concerns regarding the quality of IC4 trainsets, stemming from DSB's experience of the first 4 trainsets to be operated in Danmark between 2005 and 2008 (although these were never handed over to DSB) and the 14 NT trainsets delivered in 2008 and 2009.

To mitigate these concerns for the post-Settlement production by AB, IC4PT instigated two actions:-

- increased DSB inspection of trainsets at AB production sites in Italy; and
- introduction of an independent Umpire (a rolling stock consultancy not located in Danmark) to resolve inspection issues between the two parties.

### 2.5.2. Resident Inspection

Resident Inspectors are appointed by rolling stock procurers or their agents to witness key production stages, including tests, at a manufacturer's workshops. In the case of IC4, DSB has appointed its own resident inspectors to be located at AB production sites in Italy. This commenced in 2004 with some small increases thereafter.

However, with the increase in AB's production facilities from April 2010 and a wish to facilitate inspection at earlier stages in the production cycle, DSB increased their inspection capability to 20 Resident Inspectors located across all 5 AB production sites in Italy. These increases were implemented progressively in April 2010, May 2010, and August 2010.

A fundamental problem for DSB's post-Settlement inspection programme was that the design configuration and quality benchmarks were set by trainset 5622, then in Danmark. Thus, in order to avoid lengthy disputes between the two parties over inspection issues causing delays to production, they agreed jointly to appoint an Umpire.

### 2.5.3. Umpire

Under the Settlement Agreement, AB and DSB agreed to introduce an independent third party, termed the Umpire, in order to protect their respective interests. On 30 Nov 09, AB and DSB signed a Consultancy Agreement with Interfleet Technology (a UK-based rolling stock consultancy) appointing the latter to the role of Umpire. According to this Agreement, the Umpire witnesses tests on the trainsets, leads inspections of the trainsets, and decides irrevocably upon any disagreement between the two parties regarding the quality level achieved by each train set and on whether or not a trainset fulfils the conditions for approval.

Furthermore, the Umpire has the authority to decide whether a trainset can be shipped to Danmark and whether the completed trainset can be taken over by DSB. For these purposes, the Umpire was given authority to sign Shipment Certificates and Takeover Protocols.

However, on entering into the Umpire Agreement in January 2010, AB and DSB were confident that they could at that time resolve issues on inspections, tests, and verifications directly between themselves with no need to involve the Umpire. Accordingly, it was agreed that the Umpire's authority to approve inspections, tests, verifications and to sign certificates and protocols would be suspended, but that, at any time, either party would be entitled to request the Umpire to resume its work with regard to either a single issue or on a permanent basis.

Since then, AB and DSB found themselves at variance on a number of occasions and, in order to solve such disagreements and possibly to prevent further ones, the Umpire was called in a number of times to witness quality inspections and to express himself on the quality level achieved by a trainset.

However, by March 2011 DSB was again concerned at the number of issues being raised by their inspectors at the various production stages. In addition, the first MPTO P1 trainsets had entered passenger service in January 2011 and were exhibiting a very poor operational reliability performance despite some 250 modifications by AB from the NT design configuration to the MPTO design configuration and subsequent modifications by DSB designated Pack 1 (see Section 2.2).

To resolve the situation, IC4PT considered two possible courses of action:-

- to press on with deliveries and entry to service of MPTO P1 trainsets and repair emerging faults in service; or
- to increase inspections across the complete production cycle in AB, in IC4PT, and with increased running in simulation before entry to passenger service.

The latter course was chosen with the result that as from March 2011 a more rigorous inspection regime was introduced in Italy and Danmark and running in simulation is to be increased from 5,000 km up to 20,000 km for Pack 1+2 fitted trainsets.

AB considered that the more rigorous inspection regime was again introducing delays into their production programme and therefore decided, as they were entitled to do, to re-instate the Umpire. AB formally notified DSB on 20 Jun 11 of its intention to re-engage the Umpire and issued an instruction to Interfleet Technology on 06 Jul 11 to resume its full involvement in accordance with the Consultancy Agreement.

### 2.5.4. Impact upon Performance

There is a widely held public perception in Danmark that the operational performance of IC4 trainsets is due to lack of quality in manufacturing by AB. Conversely, AB holds the view that the poor performance is due to delivered trainsets being stored by DSB awaiting fitment of the IC4PT modifications and incorrect maintenance by IC4DT. Both views have some superficial merit, but neither view represents the complete picture.

Operational functionality of each trainset is thoroughly checked by combinations of static and dynamic tests and any lack of functionality, as compared with trainset 5622, has to be corrected in order for the trainsets to be taken over by DSB. The question can then be asked - why in that case do faults arise in traffic when the trainsets have been tested? The answer has two parts:- i) all complex systems can generate random and intermittent faults which will not be found and eradicated in one-off testing and thus, for IC4, increased running in simulation is a good form of mitigation and, ii) the trainsets are not loaded and have no interaction with train crew or passengers and it is therefore preferable for simulation to replicate as far as is practicable the experience of passenger service.

It is clear that there have been workmanship issues and that those related to long term storage, loose or incorrectly fitted mechanical fixings or electrical wiring, water ingress, or damage during construction can cause traffic disrupting incidents. However, this type of fault is generally easy to find and correct and does not generate repetitive faults. DSB claim that they typically carry out approximately 700,000 DKK worth of work on each trainset post-handover, to address 'workmanship' issues before trains enter traffic.

While there have certainly been a large number of inspection issues (URNs 010/185/186/208/213/226), the design configuration to be manufactured by AB, as represented by trainset 5622, was agreed and frozen by DSB under the Settlement Agreement and the manufacturing quality issues have had minimal impact upon operational performance.

Recent and current deliveries still generate a larger than desirable number of inspection issues which the Umpire has to adjudicate upon, but those reports seen by AT (URNs 185/186/208/213/226) suggest that the majority of these are very minor and, in many cases, cosmetic.

Thus, it is considered overall that the inspection issues described above have not contributed significantly to the poor operational reliability performance exhibited by MPTO P1 trainsets to date. Nevertheless, it is recommended that the present inspection regime, including full deployment of the Umpire, continues to the end of the build. However, priorities should be set for the respective AB, DSB, and Umpire inspection teams to focus on quality issues with adverse impact on 1) safety, 2) reliability, 3) maintainability, 4) inter-action with operating staff and passengers, and 5) passenger perceptions.

## 2.6. Approvals

There have been allegations in the public domain that TS has delayed type approval of IC4 trainset design configurations which has in turn caused delays to the project.

It is not unusual for an approval body to be blamed for delay in or rejection of an application when they do not meet the requirements of the approval process or the application itself is deficient. However, all regulatory regimes require that the applicant for an approval is fully responsible for complying with the requirements of the process and the provision of documentation and evidential information. This principle is well known throughout Europe, not just in the rail industry, and should now be well understood by all major train manufacturers and railway operators.

In the case of the IC4 project, the approval body is TS and, up to the Settlement Agreement, it was the responsibility of AB to achieve type approval with AB submissions conforming to their document "Authority Approval Process Plan" (URN 041). Under this process, AB obtained Conditional Type Approval for the NT+ trainset design configuration in January 2009 (URN 049) and for the C-MTTA (PTO) trainset design configuration (Trainset 5622) with an Addendum in May 2009 (URNs 102/101). The NT+ trainsets were approved for passenger service in single set operation in local traffic only whereas the PTO trainset was approved for limited operation in 2-set coupled multiple train formations.

After the Settlement Agreement, it became IC4PT's responsibility to obtain type approval and their submissions have to conform to their document "IC4-program Sikkerhedsplan For IC4- og NT-flåden (MTTA og STTA driftsformen" (URN 008). Conditional Type Approval for the MPTO P1 trainset design configuration was obtained in November 2010 (URN 042). IC4PT plan to obtain Type Approval for MPTO trainsets fitted with Packs 1 and 2 in October 2011, but we consider that November 2011 is more likely.

TS cannot review and comment upon applications for various reasons, including legal liabilities, and so can only accept or reject an application. As AB had found problems with meeting the approval body's requirements in the period up to 2008, TS suggested in May 2008 that AB introduce an Independent Safety Assessor or ISA to review the safety case and type approval submissions (it is now a mandatory requirement in Danmark for major safety cases to be reviewed and endorsed by an ISA before submission to the approval authority).

We have reviewed the type approval process since the Settlement Agreement in May 2009 with the following results:-

**Table 2.6.A - IC4 Type Approvals**

| Application Date | Application By | Design Configuration | Multiple Train | Approval Date | Approval Level |
|---|---|---|---|---|---|
| 23 Dec 08 | AB | NT+ | 1 | 27 Jan 09 | Conditional |
| 17 Apr 09 | AB | C-MTTA | 2 | 04 May 09 | Conditional |
| 27 Jun 10 | IC4PT | NT+ | 1 | 09 Jul 10 | Full |
| 08 Oct 10 | IC4PT | MPTO P1 | 2 | 04 Nov 10 | Conditional |
| 09 Nov 10 | IC4PT | NT Pakke 1 | 1 | 24 Nov 10 | Conditional |

It can be seen from the Table above that the approval of acceptable submissions has not been delayed with he timescales for the approval authority's assessments ranging from 2 weeks and 5 weeks (the latter over a Christmas and New Year period).

In the case of the 08 Oct 10 application, this was first submitted to TS by IC4PT on 24 Aug 10. TS considered that the application did not meet their requirements. The two parties discussed how to proceed and it was decided that TS would commence assessment of the submitted documentation with a full submission to follow.

There are other approval stages comprising the following running permits:-

- Restricted Test Run (RTR) approval which gives permission for a trainset to run under test conditions on a closed (i.e. closed to other traffic) section of the Banedanmark network.
- Permit for entry to passenger service.

RTR is undertaken by each trainset shipped to Danmark and before Takeover by IC4PT. Both AB and IC4PT claimed that RTR permits had been delayed by TS, but TS stated that their typical response time was between 1 and 5 working days. As an example, AB claimed to us on 27 Jul 11 that trainset 50 was stood awaiting an RTR permit. TS were able to demonstrate that the relevant RTR permit had in fact already been issued on 07 Jul 11.

We do recognise, however, that there are 2 issues that require RTR permissions to be expedited:-

- any delay to an RTR causes consequential delay to the Takeover by IC4PT and this then impacts upon AB's delivery and payments schedule; and
- following the issue of an RTR permit, it is necessary to make the operational arrangements for access to the 'closed' line and for drivers and this is another possible cause of delays to the delivery programme.

TS and IC4PT have been discussing the possibility of a generic RTR permit to cover the fleet with individual RTR permits to be issued internally by DSB; we understand that discussions have now reached a successful conclusion and a generic permit issued.

IC4PT expressed concerns to us at the time period to obtain the Permit for entry to passenger service, stating that it had taken 8½ weeks from October 2010 to January 2011 being issued on 17 Jan 11. As a result, IC4PT had proposed to TS a generic fleet Permit for unrestricted entry into passenger service. However, TS stated quite definitively that this would not be possible as it would not be permitted under the approval process and, in any case if it were permissible, it would be inhibited by the large number of different Design Configurations applicable to various trainsets at various times during the delivery programme.

The final part of the approval process is the approval of modifications, designated CFGs, whether grouped into 'Packs' or a individual modifications. Each CFG is subjected to a rigorous process of assessment and approval in accordance with IC4PT's quality procedure (URN 011) with the following steps:-

- preparation of draft technical specification and safety certificate;
- hazard workshop planned and implemented;
- final requirements prepared;
- requirements verified including hardware and software integration and other activities;
- development and construction;
- examination of the design solution for compliance to the requirements;
- production of the first article;
- test and inspection;
- validation of the modification requirements compared with the test results obtained; and
- handover to production

The hazard workshop is held in accordance with URN 011 and IC4PT's Safety Plan (URN 008) to identify whether a proposed CFG is safety-critical or not. If it is, the CFG is also submitted to internal validation, assessment by an Independent Safety Assessor (ISA) within DSB, and external ISA, and, finally, to the Safety Approval Authority (TS).

Clearly, the process outlined above for approval and implementation of CFGs is thorough and rigorous. However, we consider the urgency with which the implementation of reliability improving modifications are required, see Section 5 of this Report, means that the process should be applied in a more agile manner so as to minimise the turnround time from identification of the root cause of a failure to implementation of the solution as a CFG.

# 3. Current Problems with IC4

## 3.1. Current Technical Problems and their Rectification

### 3.1.1. Introduction

IC4 is fitted with an Integrated Diagnostic System (IDU) in each driving cab. This presents alarms, fault reports, and condition monitoring and diagnostic information to the Driver. It also records this data for download by maintenance personnel. Faults recorded by the IDU are designated in decreasing order of severity as:-

A(-T) a fault that prevents operation of a trainset through the Great Belt tunnel
A top level fault
B lower level fault
C information to maintainers
D information to Drivers

However, the primary system used by DSB for monitoring the operational technical stability of trains is designated DTO. This, in conjunction with RDS (an operational stability system) and TRIT (which tracks train locations by GPS and automatically alerts train controllers of delays > 5 minutes) records traffic disruptions due to technical causes (URNs 260/261). Delays due to operational causes are treated separately.

In the DTO, technical failures are categorised as:-

- train delays < 5 minutes due to a technical fault
- train delays ≥ 5 minutes due to a technical fault
- train breakdowns where a train has to be taken out of service due to a technical fault

The DTO data is recorded and analysed and, for each fleet of trains, monthly statistics are produced and a monthly status meeting is held to consider the reported performance of the trains over the previous month. The two main statistics considered are “km between incidents” (where an incident is a delay ≥ 5 minutes due to a technical fault) and “km per breakdown” (where a train is taken out of service due to a technical fault.

However, the key performance indicator (KPI) used by DSB to monitor the operational stability of trains is “km between incidents” and, for the purposes of this Report, we have defined an ‘incident’ or “delay ≥ 5 minutes due to a technical fault” as a ‘casualty’.

However, it is essential for any monitoring and improvement of operational reliability to investigate reported faults and then to identify the ‘root causes’. Only by the correct identification of root causes and their frequency can effective rectification measures be prioritised and implemented. This process is described and considered further in Section 5 of this Report.

For the IC4 fleet we have assessed the DTO monthly reports from March 2011 (which included January and February 2011 statistics) to July 2011 for MPTO P1 trainsets (URNs 001/002/003/004/029/032/033/034/035/192/193/194/233/234/235). From these reports, it is apparent that the reliability of IC4 MPTO P1 trainsets from their introduction to traffic in January 2011 up to the end of July 2011 has ranged between 1,200 km/casualty and 2,500 km/casualty per month with an average of 1,771 km/casualty.

Additionally, IC4DT analysed the performance of 6 MPTO P1 trainsets in passenger service from February 2011 to August 2011 (URN 277). In this analysis, the number of casualties per trainset and the distance run by each trainset in km were factored up to provide an equivalent total for the 6 trainsets of 544 casualties per 1,000,000 ($10^6$) km together with a breakdown of casualties per $10^6$ km per trainset system or component. The total of 544 casualties/$10^6$ km equates to 1,837 km/casualty across the fleet of 6 trains subjected to analysis.

From this information, we have identified and ranked the severity of technical problems with IC4 over this period as shown in Table 3.1.1.A overleaf. However, it must be recognised that this ranking is highly provisional in that it is based on the rate at which casualties are reported and not on the rate at which root causes of failures occur.

**Table 3.1.1.A - Current Technical Problems with IC4 MPTO P1 Trainsets**

| Report Section | System or Component | Status of Current Technical Problem | Casualties per $10^6$ km | Reliability Impact |
|---|---|---|---|---|
| 3.1.3 | Coupling System | Highly unreliable and complex mechanical system which is not currently used in passenger service so the casualty rate is low but it is clearly the top priority for rectification. | 29 | 1 |
| 3.1.2.1 | Exterior Footsteps | The single highest generator of casualties by far, but rectification is planned in Pack 2D. | 226 | 2 |
| 3.1.2.2 | Brake System | A spread of causes due to various failure modes which are undergoing analysis and investigation. | 98 | 3 |
| 3.1.4 | Train Computer Management System (TCMS) | Blamed for most of the IC4 problems, in fact most casualties are caused by spurious fault alerts to the Driver for which rectification is planned. | 54 | 4 |
| 3.1.2.3 | HVAC System | A significant number of technical issues which generate casualties when Driver or passenger comfort is sufficiently impaired.  Rectification measures are to be implemented in Pack 2D. | 22 | 5 |
| 3.1.2.4 | Powerpacks | Casualties caused by compressor failures and shut-downs which are partially rectified but with further investigations on-going. | 20 | 6 |
| 3.1.2.5 | Battery Chargers | A relatively high failure rate, the causes of which are under investigation. | 17 | 7 |
| 3.1.2.6 | Axle Reversing Gear (ARG) | A problem with engagement of Forward or Reverse gear first recognised in 2007 and partially rectified at that time, a further modification is to be implemented shortly. | 15 | 8 |
| 3.1.5.1 | Dead Man's Pedal (DMP) | Switching faults cause unwanted emergency brake applications resulting in traffic delays, it is to be rectified in Pack 2D. | n/a* | Low |
| 3.1.5.2 | Locked Toilets | Automatic locking out of use due to various fault modes which are to be investigated. | n/a* | Low |
| 3.1.5.3 | Ground Faults | Has been a problem, but now has a low incidence which is to be monitored. | n/a* | Low |
| 3.1.5.4 | Door System | There are a number of technical problems which do not impact upon reliability and which are to be rectified in Pack 2. | n/a* | Low |
| 3.1.5.5 | Driver's Seat Lock | Drivers have reported seats that are not actually faulty. | 0 | 0 |
| 3.1.5.6 | Noise and Vibration | Major improvement following fitment of a completely new engine exhaust system to MPTO trainsets, but reports of excessive noise and vibrations persist. | 0 | 0 |
| 3.1.5.7 | Wheelsets | Possible emerging problem of wheel tread condition which requires investigation. | 0 | 0 |
| 3.1.5.8 | Passenger Information System (PIS) | Severe problems initially with both hardware and software which have been largely rectified. Some minor modifications are planned, but with no impact upon reliability. | 0 | 0 |

* In the Table above, n/a means that discrete data was not available for these components in terms of km/casualty.

The Table above records 481 out of the total of 544 casualties/$10^6$ km. The other 63 are not attributed sufficiently clearly to the type of failures to be included in the Table. The current status of each technical problem listed in Table 3.1.1.A and its rectification is detailed in the following Sections 3.1.2 to 3.1.5.

It is important to note that there are no reported reliability problems in major components such as engines, gearboxes, clutches (apart from the ARG issue), bogies and suspensions, and doors and doorgear (apart from the footstep issue). It can therefore be concluded that the fundamental systems and major items of equipment fitted to IC4 are sound and are currently operating reliably.

### 3.1.2. Mechanical and Electrical Parts

#### 3.1.2.1. Exterior Footsteps

The exterior doors on IC4 are located at the centre of each vehicle for operating reasons. However, this causes excessive stepping distances (the horizontal gap between platform edge and train footstep at curved platforms) and IC4 is therefore fitted with retractable footsteps at all exterior passenger doorways. The footsteps can deploy to a maximum range of 500mm, but are equipped with sensitive edges (electrical detection of an obstruction) which allow the footstep to deploy until it meets a platform edge so that platform to footstep gaps are eliminated (URNs 253/254/255/256/257/258/259/281).

The exterior footsteps have generated by far the highest number of casualties due to the following problems:-

- footsteps failing to deploy correctly;
- footsteps deploying but doors fail to open;
- footsteps repeatedly cycle in and out;
- footsteps stick on platform edges.

The exterior footstep is part of the safety-critical door system and comprises a complex set of equipment with a motor-drive system, two sets of sensitive edges, limit switches and safety interlocks when retracted and when deployed. It is supplied by the door system supplier, IFE, as a factory-assembled housing which is then fitted complete into the coach. The assembly contains the footstep drive and mountings, switches, the footstep itself, and a hinged sprung fascia cover. IC4PT has discussed the footstep problems with IFE and the following solutions have been developed jointly (URN 279):-

- improved adjustment of the footstep housing within the coach body to prevent binding of the footstep when extending or retracting (maintenance activity);
- CFG-DSB0093 in Pack 2D to increase the motor drive starting current to ensure reliable retraction;
- CFG-DSB0094 in Pack 2D to alter the footstep extension settings so that when the lower sensitive edge meets the platform the footstep retracts 30mm (presently 5mm) to avoid interference of the footstep and upper sensitive edge with the top surface of the platform;
- CFG-DSB0095 in Pack 2D to prevent the sprung fascia panel causing the upper sensitive edge to activate resulting in the footstep cycling in and out;
- a further modification is proposed to apply a scraper strip with brush edge on the inside face of the sprung fascia panel to prevent grit and other detritus being taken into the footstep housing when the footstep retracts.

IFE is a reputable supplier of power-operated plug door systems with a high reputation for quality and reliability. However, the retractable footstep with sensitive edges is an innovative design which has suffered from poor quality installation, long term storage, and some unforeseen interactions between platform structures and the footstep and its sensitive edges.

We consider that the proposed modifications fully address these problems and should significantly reduce the overall incidence of casualties. However, some further work should be undertaken with IFE to establish that the materials used in the footstep assembly, especially bearings, and the requirements for maintenance, especially lubrication, will not lead to long-term degradation of the equipment. Condition monitoring of the footstep operation should also be considered to pre-empt future problems.

#### 3.1.2.2. Brake System

While brake system faults rank as the third highest cause of casualties at system level, the actual faults are spread over a number of components and root causes as follows:-

- repeat casualties caused by the same fault;
- excessive fault reports from 3 specific trainsets;
- parking brake due to a sensor mounted within the brake calliper housing;
- brake test pressure settings;
- WSP (Wheel Slip/Slide Protection) sensor giving incorrect values;
- brake pipe pressure switch;
- brake control unit.

A preliminary analysis of brake system faults has been undertaken by the IC4DT Teknisk team with the following results:-

- The parking brake sensor problem is difficult to diagnose as the system does not identify the faulty sensor and the calliper housing is difficult to access and requires special tools for disassembly. This problem appeared during early operation of NT++ trainsets and then disappeared, only to re-occur on the MPTO P1 trainsets, so it may be a result of long term storage. Nevertheless, IC4PT plan to commence bench testing of a brake calliper during September 2011; to improve the diagnostic system so as to identify faulty sensors; and to modify the control software so as to ignore spurious fault reports.
- Brake pressure switch settings are to be adjusted to address the brake test problem (maintenance activity) and some software changes are incorporated in Pack 2D. Further investigation is to be undertaken which may lead to further changes.
- Investigation of the root cause of the WSP sensor problem is required.
- Investigation of the root cause of the brake pipe pressure switch problem is required.
- The brake control unit may be an emerging problem and further analysis of fault reports is required.

It is clear that further investigation of brake system faults is required in order to identify and eradicate root causes of casualty-causing failures.

#### 3.1.2.3. HVAC System

IC4 has two separate Heating, Ventilation, and Air Conditioning (HVAC) systems operating independently, one for the Driver’s cab and the other for passenger saloons. Heating is provided by waste heat recovery from the engines with heated water being piped from motor coaches to trailer coaches. Auxiliary oil-fired heaters supplied by Webasto provide heating for initial warm-up after stabling and when the engines are not running or are not generating sufficient waste heat.

There have been a variety of technical problems with the HVAC systems and casualties have been caused in passenger service when the conditions in either the driving cab or the passenger saloons have become too uncomfortable. A series of rectification measures are underway as follows:-

- Drivers have experienced cold draughts requiring additional insulation to be fitted at the front of motor coaches, improved sealing of cable entries to the cab, and the provision of heaters adjacent to the Drivers legs (CFG-DSB0075 in Pack 2D) (URN 267).
- Most of the other HVAC problems relate to the Webasto auxiliary heaters and the control and integrity of the heating system. Modifications to address these issues and to be implemented in Pack 2D are CFG-DSB0099/0100/0101/0103/0105/0106/0107/0109/0110 (URN 267).
- Some software changes are also to be introduced after Pack 2.

We consider that further investigation of HVAC faults is required in order to identify and eradicate root causes of failures that can cause casualties or passenger discomfort.

#### 3.1.2.4. Powerpacks

The IC4 Powerpacks are supplied by FPT Powertrain Technologies and, within a single underframe-mounted raft or framework, contain the engine supplied by Iveco (a subsidiary of FPT), main gearbox supplied by ZF, compressor, 400V alternator, hydraulic pump, and other ancillary equipment. There are no reported reliability problems with the engines or main gearboxes and the reported Powerpack failures are due entirely to compressor problems which have two causes:- a sticking energy-saving valve and a problem with drying towers.

The compressors have a direct mechanical drive from the engine and, therefore, cannot be turned off when there is no demand for compressed air. Unwanted compressed air is therefore vented into the engine exhaust system via an energy-saving valve. This valve was sticking due to carbonisation causing mechanical failure of the compressor resulting in an equipment shortage. The carbonisation was thought to be due to contamination from the engine exhaust system.

Modification CFG-DSB0065 was designed to prevent this problem by fitting a safety valve between the compressor and the energy-saving valve and changing out all the energy-saving valves as a maintenance activity. The CFG has been fitted to most, but not all, MPTO P1 trainsets as a discrete change (i.e. not within a modification Pack), but this has not eradicated the problem although further compressor failures are now prevented by operation of the safety valve. It is possible that the continuing incidence of carbonisation is due to oil carry-over at high temperatures from the compressor and a further modification is now proposed to prevent this by fitting a high temperature filter between the compressor and the energy-saving valve.

Compressor shut-downs have been experienced due to technical faults with the air drying towers which take condensate out of the compressed air before it is delivered to the train systems. This is under investigation, but is thought by IC4PT to be due to the setting or failure of a change-over valve. Other fleets of trains using similar equipment have experienced similar problems and a number of change-over valves should be changed out and returned to the manufacturer for diagnosis of the failure mode.

#### 3.1.2.5. Battery Chargers

There have been a large number of battery charger failures which have resulted in equipment shortages while some of the failures have resulted in casualties. The battery charger is supplied by Elettromar and it incorporates an electronic power supply unit supplied by Astrid Energy Enterprises. Under their sub-supplier contract with AB, Elettromar delivered all the battery chargers for IC4 trainsets in 2004.

Capacitors degrade during storage and the long term storage of IC4 coaches has resulted in many failures of capacitors in the Astrid power supply electronics board and thereby failures in the battery chargers. IC4PT is now working directly with Astrid to overcome this problem by replacing all the power supply electronics boards by new components.

Four DSB personnel have been to Astrid for training and, commencing week 44, they will remove battery charges from the trainsets, replace the power supply electronics boards, bench test the battery chargers, and refit them to the trainsets.

A further problem is that the battery chargers are failing due to over-heating. The battery chargers contain 3 cooling fans and cooling fins and are rated to operate in ambient temperatures up to 55 degC. However, temperatures up to 65 degC have been experienced in service due to the proximity of the battery chargers to the compressed air cooler within the underframe-mounted underskirt enclosure. Modification CFG-DSB0078 has been designed to install a barrier in the underskirt between the compressed air cooler and the battery charger and other electrical equipment and to improve ventilation of equipment within the underskirt. This change is currently under-going testing to establish its effectiveness prior to seeking approval and implementation.

The batteries are fitted with a temperature sensor which provides a control feedback to the battery charger. This sensor has been giving incorrect readings due to being poorly mounted. Modification CFG-DSB0118 in Pack 2D is to change the mounting and to improve the cabling from the sensor to the battery charger URN 267).

A recent emerging problem is with a terminal plate which may be due to premature ageing. This issue is currently under investigation, but IC4PT may decide in any case to change out the terminal plate when battery chargers are changed out.

IC4PT has fitted a filter to the battery charger fan air intakes and this becomes so heavily contaminated that it requires to be changed out daily by maintenance personnel. Even so, many battery chargers are now very dirty and this will be dealt with when battery chargers are changed out. Modification CFG-DSB0078 includes the fitment of additional filters to underskirt air intakes and this should significantly reduce the contamination of battery charger filters.

Most DMU designs use 24V DC electrical systems due to the ready availability of low cost automotive components and this usually includes the engine start system. In these cases it is good practice to fit separate start and auxiliary batteries as this ensures that the engines can be started from their own dedicated battery even when the auxiliary battery is in a discharged condition. In the case of IC4, it is fitted with a combined start and auxiliary battery which renders it vulnerable to starting problems. IC4PT is currently looking into ways of improving the certainty of engine starting using “Powerstart” or similar equipment.

#### 3.1.2.6. Axle Reversing Gear (ARG)

The ARG is supplied by ZF and is mounted on a driven axle in a powered bogie. It contains clutches to engage forward, reverse gear or a 'Neutral' position. When a trainset stops at an intermediate location such as a station, a clutch between the engine and main gearbox disengages to allow the engine to continue turning while the transmission system is stationary.

However, when the driver selects a change of direction from forward to reverse or vice versa, the ARG clutch occasionally fails to engage due to mechanical tooth-to-tooth interference with the result that no traction power is available from that engine/transmission system. IC4 is designed to be able to meet the timetable with 3 Powerpacks operating and can ‘get home’ with only two operational but, in the latter case, the loss of power will cause train handling problems, wheelslip in poor adhesion conditions, operating delays, and will also prevent the trainset running through the Great Belt tunnel which is an A(-T) fault condition.

This problem was first recognised in 2007 and a modification was introduced to allow the ARG gear selection to attempt engagement 3 times before being reported as a fault. Although this significantly reduced the failure rate to around 1% occurrence per operation it did not entirely eliminate the problem. A further modification has been developed with ZF to modify the main gearbox control software (also supplied by ZF via the Powerpack supplier FPT Powertrain Technologies) to permit a momentary rotation of the drive system and then re-attempt ARG clutch engagement. A similar solution had been introduced previously to IC3.

The initial modification was incorporated in all MPTO trainsets by AB whilst the latest modification is designated CFG-DSB0119 for which safety approval is expected in October 2011. As a software change which is capable of being implemented across the fleet quickly, this CFG is not incorporated into the Pack 2 programme, but is planned for completion across the fleet by December 2011.

Whilst it is surprising that this problem was not eliminated at build by ZF, given that it had been recognised and resolved previously on IC3, the proposed course of action by IC4PT is appropriate and should eliminate the problem with a consequential small impact on reliability improvement.

### 3.1.3. Coupling Trainsets

DSB’s operational strategy for long-distance Inter-City and inter-regional traffic requires frequent coupling and uncoupling of trainsets in passenger service so that passengers can travel to their destination without having to change trains en route. We were informed that some 150 coupling and uncoupling operations are conducted every day with the majority involving IC3 trainsets (this figure has not been verified). While other railway administrations do couple and uncouple in passenger service, the frequency of such operations in Danmark makes this a unique and challenging engineering requirement.

From the outset, IC4 has been seen to have severe problems with coupling and uncoupling and operating with multiple trainsets in coupled condition. In principle, problems can arise from the following areas which are addressed individually in the following sections:-

- the coupler, i.e. that part that engages mechanically, electrically, and pneumatically with the coupler on another trainset;
- the coupling system;
- the Train Control Management System (TCMS); and
- other train systems that communicate through the couplers.

#### 3.1.3.1. The Coupler

The coupler is a standard product supplied by Dellner and is used in both fixed and retractable arrangements on many trains throughout Europe. It is regarded as highly reliable.

While other trainsets are fitted with retractable couplers and covers similar to those on IC4, most are used for emergency rescue only and none are used in the type of operation in passenger service required by DSB.

#### 3.1.3.2. The Coupling System

The coupling system adopted for IC4 is complex and has the following design features:-

- Operation by one driver from within one driving cab.
- Wireless cab-cab communication.
- Front plug-type sliding covers that retract inside the vehicle.
- Couplings that extend and retract to enable the front covers to deploy.
- An intermediate cover and bellows that deploys after the coupler extends.
- Safety interlock switches on all stages of the coupling and uncoupling process.

IC4 MPTO P1 trains have undergone verification testing and have received TS type approval for operation in 2-trainset coupled condition. However, the current unreliability of the coupling system has almost completely inhibited DSB from employing coupled trainsets in passenger service while coupling and uncoupling in passenger service has not been attempted at all. A Task Force has been created to investigate and rectify the coupling system problems, but the only modification currently envisaged is a minor change to the front cover interlock switches. Two technicians are working full-time on the mechanical faults including riding on IC4 trainsets.

To further our understanding of the coupling system, we requested IC4PT to arrange a coupling demonstration which we could witness both from the Driver's cab and from the ground. This took place at Århus using trainsets 5641 and 5642 with two test drivers who were thoroughly familiar with the operation of IC4 trainsets. During a sequence of 5 coupling and uncoupling operations in ideal conditions there were 2 failures to complete the coupling sequence and 2 failures to complete the uncoupling process, a 40% failure rate. Furthermore, each of the 4 failures exhibited a different failure mode and in none of the failed operations was the root cause of the failure known or understood.

We consider that it is essential for the IC4 coupling system problems to be resolved in order for the fleet to enter long-distance Inter-City and inter-regional traffic as planned. For this to be achieved, the coupling system must attain a level of operational reliability comparable with that currently offered by IC3.

We further consider that the present system is too complex to achieve these objectives no matter how much effort is directed toward investigating and rectifying the problems by modification of the system and its components. We therefore recommend that the IC4 coupler is locked in its extended position and the equipment associated with extension and retraction of the coupler removed. Specifically:-

- the coupler should be locked in its extended position as per IC3;
- the front covers and intermediate moving cover and bellows should be removed;
- the front cover and intermediate cover drive mechanisms and interlock switches should be removed;
- the cab-cab wireless should be removed; and
- a new cover and bellows should be designed and fitted to seal the coach front end.

We held a joint Workshop with IC4PT and IC4DT to define the steps necessary to achieve locking of the coupler in its extended position which found the following:-

- The coupler locks mechanically in its extended position, but some changes to the pneumatic controls for coupler extension and retraction would be required.
- The front and intermediate covers and their drive mechanisms and safety interlocks would become redundant.
- The cab-cab wireless would become redundant.

- Advice will be required from Dellner concerning the forces experienced by the coupler when permanently extended. This might require additional support to the draft gear or even replacement by an alternative design.
- Uncoupling is currently achieved by retraction of one of the couplers, but with a locked extended coupler it is necessary to move the train (as per IC3). This will require changes to the TCMS and, possibly, the Brake Control Unit (BCU).
- A new front cover and bellows will have to be designed and fitted which would be fixed in passenger service but removable for maintenance access.
- The modification would have to undergo the CFG process for design, testing, and approval.

Given that this technical problem has the highest priority for rectification, it is considered that the modification should be designed and approved within 6 months with fitment over the following 6 months so that reliable coupling can be achieved as from October 2012. This is a challenging timescale but resolving the coupler issue is of paramount importance if the fleet is to be deployed in inter-regional traffic.

It is not possible to provide a cost estimate for this modification until further definition of the detailed scope of work has been completed. It is likely to be relatively costly, but the future operation of the IC4 fleet in long-distance traffic almost entirely depends upon its success.

Until such time as the coupler solution is implemented, it will be necessary to operate the IC4 trainsets in ‘fixed formations’, i.e. coupling and uncoupling only at maintenance depots. Even then, to obtain a sufficient level of reliability, special attention should be paid to interlock switches being positioned and operating correctly so that these do not trip out in traffic with consequential operating delays.

#### 3.1.3.3. TCMS

The operation and reliability of TCMS and its relationship with multiple coupled trainset operation are considered in Section 3.1.4 below.

#### 3.1.3.4. Other Train Systems

Key train sub-systems that require to communicate via the couplers when operating in multiple coupled-trainset condition include traction control, brake control, door control, and PIS. It is not unusual for faults to occur in these systems when coupled which do not occur when operating as single trainsets for a variety of reasons and this is true of IC4. However, they should be identified and investigated as issues with the particular sub-system concerned and not classified as coupling faults and that is our approach for this Report.

### 3.1.4. Computers

The Train Computer Management System (TCMS) on IC4 comprises hardware and software for:-

- two Train Computers (CCU) fitted one in each Motor coach;
- four Coach Computers (RIO) fitted one in each coach;
- two Integrated Diagnostic Units (IDU) fitted one in driving cab; and
- interfaces with other train sub-systems.

Within a trainset, these various computers interface with each other and with the train sub-systems via a databus. This trainset databus connects to a train databus via a Gateway Unit fitted to one Motor coach and the train databus passes through the coupler electrical connections to other trainsets (URN 037).

TCMS is designed to carry out a number of key functions for train control, door control, and management of other sub-systems, most of which have their own micro-processor controlled functionality, and is also designed to operate with up to four IC4 trainsets operating in multiple.

It is widely perceived in Danmark that flaws in the TCMS are the cause of the long history of coupling and other problems with IC4. There has also been recent public speculation that the TCMS architecture is fundamentally flawed. We find this not to be the case and consider that the TCMS design has the basic functionality required of it. TCMS and IDU deliver fault messages and as such the public perception of TCMS is a classic “shoot the messenger” syndrome. The actual problems with the IC4 TCMS, as distinct from the perceived problems, are comparable to the problems experienced by other manufacturers in the sometimes painful development of their own train control management systems.

The inability of AB to obtain type approval for multiple operation was more a matter of lack of verification and testing to prove the system functionality within the timescale required by DSB's Ultimatum of May 2008 rather than of design flaws. Nevertheless, as described in Section 2.2 above, DSB decided to upgrade the TCMS by awarding a contract to AB with delivery structured in 20 phases (URN 201):-

- IC4 Software Package 1 to include multiple 2-coupled operation
  - Phase 1 Design
  - Phase 2 Development
  - Phase 3 Test
  - Phase 4 Approval
  - Phase 5 Installation
- IC4 Software Package 2 to include multiple 3-coupled operation
  - Phase 6 Design
  - Phase 7 Development
  - Phase 8 Test
  - Phase 9 Approval
  - Phase 10 Installation
- IC2 Software Package 1
  - Phase 11 Design
  - Phase 12 Development
  - Phase 13 Test
  - Phase 14 Approval
  - Phase 15 Installation
- IC2 Software Package 2
  - Phase 16 Design
  - Phase 17 Development
  - Phase 18 Test
  - Phase 19 Approval
  - Phase 20 Installation

Phases 11 to 20 are optional and the contract also includes the option for DSB to request further development of TCMS. Software maintenance for 5 years from completion of the warranty period is included in the contract. No hardware changes are included in the contract.

Phases 1 to 5 were delivered on time and type approval was obtained from TS in November 2010 so that MPTO P1 trainsets have the functionality and approval to operate in multiple 2-coupled train formations. Phases 6 to 8 have been completed on time and type approval for multiple 3-coupled train formations is expected in October 2011. Since January 2011 a joint IC4PT / AB working group has managed the upgrade contract and we find that this relationship is working well and to date has delivered its objectives fully and as scheduled. Changes to the TCMS to be implemented in Pack 2D are designated CFG-DSB0097 (TC changes) and CFG-DSB0098 (IDU changes).

IC4PT now has to decide whether to request further development of TCMS to implement multiple 4-set train formations and whether to initiate the option to upgrade IC2 TCMS.

Notwithstanding the above, there is one specific known problem with TCMS and the IDU which is that a high level of A and B alarms are being generated (URNs 270/271) and, in many cases, these are spurious or repeat alarms. However, as an A alarm requires a Driver response it frequently results in a casualty. AB has experienced similar problems elsewhere and has implemented a software filter to mitigate the problem and the same solution is proposed for IC4.

IC4PT has identified all the A alarms which may require to be filtered out or down-graded to a lower alarm level and from this has devised a set of 10 rules for filtering which will be installed in Pack 2 as version 1.6. The Team is now developing version 2.0 of the software to contain 125 rules and implementation of this version should have a significant impact on IC4's operational reliability. The filter software has been developed so that the application of rules can be revised in the light of further operational experience without further changes to the software and DSB personnel have been trained by AB to undertake this function.

### 3.1.5. Other Technical and Quality Problems

#### 3.1.5.1. Dead Man's Pedal (DMP)

The DMP is a safety device used to ensure that the Driver is able to drive and, in various forms, is a standard fitment in driving cabs. In IC4 it comprises a sprung pedal which the Driver must keep depressed while the train is in motion. If released either inadvertently by the Driver or due to the Driver becoming incapacitated an emergency brake application ensues.

The DMP fitted to IC4 has proved to be too flimsy and this has caused switching faults which can then result in traffic delays due to unwanted emergency brake applications. It is to be strengthened by modification CFG-DSB0116 in Pack 2D.

#### 3.1.5.2. Locked Toilets

The toilet compartments in IC4 are fitted with SEMVAC vacuum toilets which discharge waste into underframe-mounted retention tanks. There are three toilet compartments in IC4, one standard compartment in each of the Motor coaches and one disabled access compartment in the low-floor section of the T2 Trailer coach.

Vacuum toilets for railway trains were first developed by SEMVAC (formerly SEMCO) for fitment to DSB's IC3 trains. They are now widely fitted to European passenger rolling stock and have a good reputation for reliability. However, it is necessary to prevent use of a toilet if it is either operating incorrectly, has run out of water for flushing, or the waste retention tank is full. This is normally achieved by condition monitoring of the toilet equipment and automatic locking of the toilet compartment to prevent further use of the toilet. When locked, this is a nuisance for passengers, but would only cause a train to be taken out of service if all three of the toilets were locked out of use simultaneously.

Locked toilets have been reported on IC4 due to various failure modes which require further investigation in order to determine the root causes of the failures. In the meantime, maintenance attention is to be increased and a temporary solution to a waste pipe problem is to be fitted.

#### 3.1.5.3. Ground Faults

Ground faults in rolling stock electrical systems are rare and usually result from poor maintenance, damage, or water ingress to electrical equipment or cabling. Electrical circuits are tested after original installation or any modification for insulation between the circuit and ground in order to determine that there are no ground faults or potential ground faults in that circuit. This is commonly known as a 'megger' test after the name of the company that first introduced suitable test equipment.

However, IC4 has suffered from a large number of ground faults at build and subsequently. There is no hard evidence as to the causes of these ground faults, but they are likely to be due to a combination of long term storage and poor workmanship. IC4PT considers that the present incidence of ground faults must be monitored, but has no immediate plans for an investigation.

#### 3.1.5.4. Exterior Door System

Although the exterior door system is operating reliably except for the footstep problems described in Section 3.1.2.1 above, there have been some other technical problems which are to be rectified by modifications in Pack 2D and 2A.

Each doorway is equipped with an external staff service pushbutton which is mounted behind a locked panel. Use of the staff service pushbutton bypasses the door safety systems so that staff can access a coach in any situation. This pushbutton has experienced switch contact problems which could allow the doors to open when in service and this is, therefore, a safety critical fault. Modification CFG-DSB0037 in Pack 2D is designed to provide improved switch contacts and a change in the software logic so that two discrete pulses of the pushbutton will be required to operate the circuit.

The door system design provides for automatic closing of the doors when standing for a period of time at a station platform. This helps to maintain the passenger environment within the coaches when the climate is either very warm or very cold. At present the doors are set to auto-close after 15 seconds and to start closing slowly as a passenger safety measure, but on occasions the doors fail to close and, after 5 attempts, a general fault is recorded. Modification CFG-DSB0096 in Pack 2D will reset the open period to 60 seconds so that auto-closing occurs less frequently and will increase the electrical current to the door motor towards the end of its travel to ensure reliable closure. This modification will have no impact upon reliability as the fault only occurs while the trainsets are standing at a station and door closure (of any open doors) is controlled by the Driver prior to departure.

A safety modification CFG-DSB0117 in Pack 2D will fit a second switch to each internal Emergency Door Handle as a safety modification. At present there is one switch which, when operated by a passenger, trips the Door Interlock System (an electrical circuit designed to ensure that the train can only be moved when all exterior doors are closed and locked) and alerts the Driver. However, if a door has been isolated (i.e. locked out of use and the Door Interlock System at that door bypassed) and a passenger operates the Emergency Door Handle at that door, it does not trip the Door Interlock System and the Driver is not aware that an Emergency Door Handle has been operated. Fitment of the second switch will overcome this problem.

Modification CFG-DSB0048 in Pack 2A will improve the attachment of locks on interior door header panels as a safety measure.

Modification CFG-DSB0025 in Pack 2D will fit a sun blind to the exterior side doors in the driving cabs as a safety measure.

Consideration is being given by IC4PT to linking the Door Interlock System in each coach to that coach's RIO (Coach Computer) to improve diagnosis of door system faults and to avoid excessive volt drop when in multiple 4-set coupled configuration.

#### 3.1.5.5. Driver's Seat Lock

There have been DTO reports of problems with the Driver's seat controls. This is not a technical problem as the Drivers have questioned the seat operation although it is operating as designed and is not faulty.

#### 3.1.5.6. Noise and Vibration

From the outset of operation of IC4 trainsets, they have been considered to be uncomfortable due to high levels of interior noise and vibration. Much of the early problems were overcome by the complete re-design and fitment of a new engine exhaust system which was also required to rectify the transmission of exhaust fumes into passenger saloons.

However, reports of excessive noise and vibration continue to be made and anecdotal evidence was provided to us by a number of sources. Our own experience of two trips on IC4 trainsets from København to Århus was that, subjectively, the interior conditions were similar to most DMUs including IC3, but we recognise that excessive noise and/or vibration may only occur in certain operating conditions and that these conditions may not have arisen on our journeys.

IC4PT considers that excessive noise in passenger saloons, when it occurs, is due to the engine exhaust system where it passes through the coach bodies from the floor to exits above the roof. Although the new exhaust system was a big improvement, problems remain that will require investigation.

In respect of excessive vibration, IC4PT has developed a number of modifications to reduce or eliminate excessive vibrations as follows:-

- CFG-DSB0056 in Pack 2A will eliminate vibrations caused by contact between Powerpack frames and coach bodies.
- CFG-DSB0091 in Pack 2A will eliminate vibrations caused by contact between Powerpack frames and pipework.
- CFG-DSB0092 in Pack 2A will eliminate vibrations caused by contact between Powerpack frames and hydraulic pumps.

#### 3.1.5.7. Wheelsets

There is some evidence of an emerging problem with wheel tread condition which may lead to an increased frequency of tyre-turning (i.e. machining the wheel tyre either to restore the tread and flange to their design profile or to recondition the tread to remove damage due to wheel slide or flaws) which will shorten wheel life. Most railway wheels can be re-machined a few times before they have to be replaced by new wheels and fitting new replacement wheels onto existing axles is an expensive process.

Premature wheel replacement is a major maintenance cost driver, so tread condition should be carefully monitored. IC4PT stated that a specialist wheel group in DSB is looking into the problem.

### 3.1.5.8. Passenger Information System (PIS)

The PIS fitted to IC4 is supplied by FOCON and is controlled by a computer in each coach designated a Coach Controller. It fulfils a number of functions including:-

- external and internal passenger displays
- public address driver to passengers
- seat reservation system requiring ground to trainset wireless communication
- emergency public address ground to passengers requiring wireless communication

Except for the emergency public address function, which is required to permit trainsets to transit the Great Belt tunnel, the above functions do not impact on reliability. However, DSB regards the seat reservation system as an important part of its service offering to passengers.

Early IC4 trainsets suffered a large number of hardware and software problems, but these have been largely rectified such that there are now few fault reports and such faults as occur have a wide spread of causes. However, there is a shortage of spare Coach Controllers which has caused trainsets to stand out of service.

DSB staff also found the system very frustrating to use and IC4PT arranged directly with the supplier, FOCON, for additional training.

Also the PIS is now essentially reliable, there remain some further modifications to be implemented at Pack 2 as follows:-

- CFG-DSB0079 and CFG-DSB0089 in Pack 2D has software updates.
- CFG-DSB0080 in Pack 2A has changes loudspeaker wiring to prevent acoustic feedback.
- CFG-DSB0090 in Pack 2A has a change of micro-processor

### 3.1.5.9. Additional Pack 2 Modifications

In addition to the technical problems and their rectification summarised in the Sections above, there are some further modifications to be implemented in Pack 2 as follows:-

- CFG-DSB0026 in Pack 2D to improve the windscreen wiper function to meet Driver's requirements, not to overcome a technical fault.
- CFG-DSB0032 to fit a barrier to prevent leaves collecting around underframe-mounted equipment causing overheating and a fire risk.
- CFG-DSB0043 in Pack 2D has a software update to the DLU (Data Logging Unit).
- CFG-DSB0050 in Pack 2A has a safety modification to the toilet waste bin to prevent passengers suffering cut fingers.
- CFG-DSB0052 in Pack 2D is to prevent damage to the roof-mounted DLU transducer during maintenance.
- CFG-DSB0058 in Pack 2D is to prevent problems with freezing in the catering area in winter.
- CFG-DSB0081 in Pack 2A is to modify the windscreen wipers to provide a larger wiped area to improve Driver visibility.
- CFG-DSB0085 in Pack 2D is to modify the coffee machine housing so that any leaks cannot penetrate other critical equipment such as the brake system computer.
- CFG-DSB0087 in Pack 2A is a software update to the MSR (cab radio).

## 3.1.6. Operator Handling of the Trains

Some of the IC4 problems have been blamed on driver handling of the trainsets. There is some anecdotal evidence of this, especially in fault conditions where the Driver responds to a fault scenario with inappropriate actions. However, no hard evidence of a significant contribution to the current reliability performance of the IC4 MPTO P1 trains was presented to us.

Such handling issues are not unusual when new trains are introduced to service and many railway operators use driving cab simulators for driver training on new trains so as to avoid handling problems in actual passenger service. Simulators can be used for basic driver training, but their real value is in presenting drivers with fault and emergency scenarios so that, when such incidents occur in service, they have already experienced these problems and understand how to deal with them. However, driving cab simulators are expensive and require a long time to commission and, therefore, are not an appropriate solution for IC4 at this time.

When a fault occurs in traffic, the Driver can communicate by cab radio with the operating control office who can, if required, patch the Driver through to speak directly to a Supervisor in the technical office at Århus depot. Although this a useful feature, it is likely to result in delay to the train and is not a substitute for correct handling by the driver in the first place. Driver handling issues can be resolved by additional or extended training and, if necessary, driver selection based upon competence testing.

## 3.2. All Other Important Problematic Issues

Apart from technical and operator handling problems which are addressed in Section 3.1 above, there are potentially problems in the following areas.

### 3.2.1. Operating Strategy

To date the plan for IC4 has always been for the fleet to replace IC3 trainsets on long-distance Inter-City and inter-regional services, making the IC3 and IR4 fleets available to increase Inter-City and inter-regional service frequencies elsewhere and to cascade IC3 trainsets to regional services which would allow older rolling stock to be taken out of service.

Since the development of this plan in 2000, passenger demand for long-distance Inter-City and inter-regional services has increased significantly and, according to DSB, has grown by 3% per annum for the last 3 years. At this growth rate, the present 52 million passengers per annum will reach 72 million in 2023.

It is understood that in parallel with this technical review of the IC4 project, the operating strategy for long-distance traffic is also being reviewed and this will consider how the IC4 fleet can best be integrated into the train service pattern, taking into account such issues as service frequency, train length and the need for coupling/uncoupling trains to serve different destinations. The study is also expected to consider how the IC4 fleet should be deployed in the interim period whilst the coupler issues are resolved and overall reliability of the fleet is increased to an acceptable level.

This issue is considered further in Section 4.2 below.

### 3.2.2. Engineering Resources

As explained in Section 2.2 above, the IC4PT now has all the responsibilities of a train supplier and, therefore, now carries all the responsibilities for ensuring that the trainsets are engineered to a level of functionality, quality, and reliability and achieve type approval from TS so that the fleet can enter passenger traffic on long-distance Inter-City services as intended.

As a result, the project team has grown since May 2009 from a procurement organisation responsible for managing AB as main contractor to an engineering organisation capable of undertaking the necessary actions to complete the engineering and delivery of the fleet whilst continuing to manage the supply of trainsets from AB.

Nevertheless, we consider that the present engineering organisation within IC4PT is still under-resourced in terms of both manpower and production capacity if sufficient reliability growth is to be achieved within a reasonable time period. This issue is addressed in Sections 4.1.3 and 4.3 below.

### 3.2.3. Maintenance Resources

Train maintenance is undertaken in two parts:-

- Scheduled Preventive Maintenance (SPM)

- Unscheduled Corrective Maintenance (UCM)

SPM is a programme of prescribed maintenance examinations scheduled to take place at set intervals on either a time-based or distance-based periodicity. SPM programmes are usually specified by the train supplier in order to protect his warranty obligations and failure to maintain the trains in accordance with the SPM will invalidate the warranty.

The activities within each SPM examination are designed to pre-empt failures in service by a combination of maintenance activities, e.g. cleaning filters, and component replacement either on a periodic basis or when wear limits are approached.

UCM is applied when a fault has appeared on a trainset that requires rectification, i.e. a corrective action is to be applied. Unless the root cause of a fault is obvious or already known, the fault has to be investigated and the appropriate corrective action determined as either a change to operation of the trainset, a change to an SPM activity, or an engineering change to the trainset.

For IC4, AB specified an SPM programme based upon an initial post-simulation examination at 5,000 km and then periodic examinations at 15,000 km intervals with different levels of maintenance activities at each interval from 15,000 km up to 5,250,000 km (URN 115).

For maintenance depot planning purposes, a ratio of 90% SPM to 10% UCM is normally applied to determine the required depot capacity and manpower to maintain a fleet of trains. IC4DT reported to us that the current ratio of SPM to UCM for IC4 is 50% / 50% (this figure has not been verified). This is a reflection of the high numbers of fault reports for trainsets in traffic and low reliability in terms of km/casualty and is not sustainable as a normal maintenance activity.

It is planned to concentrate maintenance of IC4 at two existing train maintenance locations, København Airport and Århus, and both have been fitted out with special facilities and equipment for IC4. We have run our maintenance model (an Atkins tool used for depot planning) on a high level basis for IC4 using limited data and this suggests that the planned maintenance provision is marginal for the full fleet of 83 IC4 trainsets and this issue is therefore addressed further in Section 4.2 below.

A more detailed assessment, using our maintenance model, would be required to determine the optimum locations and use of resources (facilities and manpower) for maintenance as part of a Maintenance Strategy Study, see Section 4.2 below.

### 3.2.4. Economics

Under the Settlement Agreement, the IC4 and IC2 trainsets are being supplied to DSB subject to compensation and discounts amounting to 40% of the original contract price. However, DSB is itself incurring significant costs for the IC4PT and the further engineering development of the trainsets and it is our view that these costs will increase substantially over the next 2 to 3 years compared with the rate of expenditure over the last 2 years.

The question therefore arises as to the appropriate level of expenditure and whether, given this level, the trainsets will represent good value for money. This issue is addressed in Section 4.1.3.

### 3.2.5. Reliability

The reliability or operational stability of the IC4 fleet is by any standards very poor at less than 2,000 km/casualty. Immediate steps are essential to drive reliability improvement towards a minimum target of 15,000 km/casualty and then a steady-state reliability of more than 20,000 km/casualty.

This issue is addressed in Section 5 of this Report including the measures that need to be taken and how they should be implemented.

### 3.2.6. Supply Chain Management

As reported in Section 2.1 above, there have been delays to production in Italy and trains standing in Danmark due to materials supply shortages experienced by AB, particularly with regard to equipment missing from or found to be defective and requiring replacement when coaches were retrieved from long term storage and entered the HP1 strip-down production stage.

By early 2011, IC4PT became sufficiently concerned at the situation with AB that they commissioned Deloitte's to carry out due diligence of AB's supply chain for IC4 and IC2. Deloitte's reported in March2011 (URN 026) with the conclusion that the risk of delivery delay was high and that actions should be initiated to minimise the risk and potential impact. A series of actions with action plans was recommended for implementation.

AB responded formally to the Deloitte report on 21 Jun 11 (URN 040) stating that the recommended actions, where necessary, had been implemented.

We reviewed both Deloitte's report and AB's response with AB during our visit to Pistoia, Italy, in July 2100. We conclude that the problems that had been experienced were now under management control, although some further delays due to materials shortages were still likely to affect the NT++ trainset upgrade programme and rebuilding and modification of the 6 early trainsets that had remained in Italy, namely trainsets 5601, 5602, 5603, 5605, 5609 (which is currently in Libya), and 5610.

Under the Settlement Agreement, IC4PT can procure spares from any Finmeccanica-owned company at a 50% discount up to a ceiling of 1,000,000,000 DKK and for a limited period. IC4PT has so far purchased spares under this arrangement to the value of 68,070,870 DKK. In addition, IC4PT has purchased some spare parts direct from sub-suppliers to overcome shortages in Århus depot.

The IC4DT is responsible for spares ordering and storage for IC4. The DSB SAP system is used for this purpose with spares being ordered on a prioritised basis. IC4DT has registered some 2,000 parts on SAP with a further 500 still to be registered. When registered, a Part Number is allocated but additional detail required for spares ordering has not yet been entered to the system. When data entry to SAP has been completed, it will hold records of shelf-life, average maintenance usage, stock order quantities, etc, together with a life history including fault data.

Of the parts registered in SAP, the supply chain data is in place for 145 parts as at the end of July 2011 with a further 205 parts to be completed within a further week. IC4DT estimated that completion of the supply chain in SAP would take around 3 to 4 months to around November 2011. During this period, there is a risk of parts shortages especially for longer lead-time items. This backlog in setting up the supply chain is due to limited resources up to the present time, but IC4DT has received authority to employ a full-time Spares Manager with an increased staffing level.

It appears that SAP is a well-established and proven system and that it has all the functionality required for supply chain management. We also reviewed the Stores establishment and management at Århus depot and found no issues arising. However, IC4DT should be aware that once the supply chain for IC4 parts has been fully established, they should start considering the requirements for spares floats for component overhauls.

While IC4DT is responsible for the ordering and storage of spare parts, the parts are actually sourced from suppliers via the DSB procurement department.

### 3.2.7. Graffiti

There is a general problem of graffiti in Danmark as in many other countries and railway infrastructure and rolling stock are particularly favoured targets with many of the IC4 trainsets subjected to graffiti attacks while standing in stabling yards. Cleaning to remove the graffiti is likely to seriously degrade the exterior paint system and will certainly invalidate the paint system warranty.

We were advised that DSB has an anti-graffiti policy whereby all examples of graffiti tags are photographed before removal and recorded in a database for use in prosecutions. However, there are other measures available to rolling stock operators which can be effective in deterring graffiti or mitigating its effects. These include vehicle protection using anti-graffiti films, which some manufacturers are now providing on new trains, and security arrangements at stabling sidings including high security fencing, CCTV, and CCTV enhanced by a Public Address system.

# 4. Options for Repairing IC4 Problems

## 4.1. Possibilities for Rectification

### 4.1.1. Technical Possibilities

Present actions, plans, and further possibilities for rectification of the known technical issues are fully covered in Section 3.1 above.

IC4PT plan to increase running in simulation from 5,000 km to up to 20,000 km as a 'burn-in' period to find and eradicate early technical faults before entry to traffic. As stated earlier, simulation is most effective if it replicates as far as possible the trainset experience in traffic with loading equivalent to an all-seated passenger load and simulated station stops with the exterior doors and footsteps operated. Another option is to stop more frequently than would be the case in actual long-distance traffic, thus achieving 'braking + door operation + accelerating' cycles in a shorter distance.

Another aspect of pre-traffic simulation is the question of how to decide what distance to run before handing the trainset over to the IC4DT for entry to traffic. One method used by rolling stock procurers is to stipulate a period of 'fault-free' running, say 5,000 km. If a trainset achieves 5,000 km without an 'A' fault occurring, then it is handed over for traffic. However, the occurrence of an 'A' fault would cause the distance run requirement to start again from zero.

Although increased simulation will delay the entry of individual trainsets to traffic and increased demands on resources such as drivers and track access, it is a well-considered plan. However, from the commencement of IC4 operations in traffic to the present time, the analysis of fault reports, their investigation to determine root causes, and the prioritisation of root causes for remedial actions has been and continues to be severely constrained by lack of resources including data processing capability (methodology and capacity) and manpower for analysis and investigation.

The IDU in each trainset contains a memory with up to 10,000 lines of data which, typically, represents 7 to 14 days in traffic. However, at present, the data in each IDU is downloaded every day by a blue-collar worker to a lap-top computer and then transferred by memory stick to a desk-top computer in the IC4DT office. There is an intention to introduce radio downloads as already available on the IC3 fleet, but there is no current plan for its implementation.

The downloaded IDU data is interrogated manually which takes approximately 4 man-hours per day for the present 10 trainsets in traffic. This is not a sustainable approach when increasing numbers of trainsets enter into traffic and a degree of semi-automated data processing and filtering should be introduced.

The other main source of fault data, DTO, is an operator's system which provides only fault reports which then require investigation.

Thus, while we are satisfied that the list of technical problems presented in Section 3.1 is comprehensive and that there are currently no other significant technical problems, there is a lack of visibility of the root causes of failures which will inhibit any drive for reliability improvement.

In order to focus the IC4PT's efforts to improve reliability and to provide the means to drive a reliability improvement programme, we recommend that a dedicated Reliability Improvement Team is established within the IC4PT. This proposition is considered further in Section 4.3 below and Section 5 of this Report.

### 4.1.2. Time Perspective

The time period within which rectification of IC4 technical problems should be achieved is covered in detail in Section 5 of this Report.

### 4.1.3. Economic Consequences

The figure generally quoted in the public domain for the cost of the IC4 project is 5.5 billion DKK. However, this includes taxes and, for the purposes of this Report, we have used post-Settlement Agreement cost data which excludes taxes as follows:-

| | |
|---|---|
| IC4 | 3,771,834,000 DKK |
| IC2 | 680,701,000 DKK |
| TCMS Upgrade | 210,000,000 DKK |
| Total | 4,662,535,000 DKK |

The IC4 and IC2 contracts include the IC4 trainsets, IC2 trainsets, workshop equipment, training, and spares.

The total value of the original IC4, IC2, and TCMS upgrade contracts considered on a purchase cost/car basis was comparable at the time with benchmarks for similar European rolling stock. Thus, if the trainsets had been delivered on time and in acceptable condition they would have represented value for money.

Now, in 2011, the total contract value at is some 80% of current benchmarks for European diesel multiple unit trains, but, as a result of the Settlement Agreement, DSB obtained compensation and agreements to discounts amounting to almost 40% of the contract value. The current contract value, excluding spares, is therefore 2,845,035,000 DKK and, at this level, the IC4 fleet, IC2 fleet, and TCMS Upgrade are costing in total around 50% of the current benchmark value for comparable European DMUs.

The discounts apply at 50% of the TCMS contract value and 50% on all spares purchased from Finmeccanica companies up to a maximum value of 1 billion DKK. If the maximum value of spares is purchased, then the overall value of compensation and discounts reaches almost 50% of the original contract value.

Thus, it could be said that the trains are being purchased at half-price, but this is not the true position. DSB is incurring and will continue to incur substantial additional costs for the further engineering development of the trainsets in order to prepare them for the planned long-distance Inter-City and inter-regional services. This was recognised by DSB who allocated a sum of 800,000,000 DKK to budget for the expanded IC4PT, the further engineering development of the trainsets, and the TCMS Upgrade contract. To the end of July 2011, approximately 320,000,000 DKK (40%) of this budget had been expended in 2 years.

As discussed in Section 4.1.1 above and Section 4.3 below, it is considered that IC4PT will have to ramp up their present capacity (workshop space) and resource (manpower) and increased spending on materials and equipment can also be expected. Thus, we estimate that the per annum budget for IC4PT will need to increase from its present level by around 50% for a period of 3 to 5 years from now. This represents an increase in the 800 million DKK budget to between 1.2 and 1.6 billion DKK, i.e. an increase between 50% and 100%.

At this level of expenditure, the overall purchase cost/car is between 80% and 90% of the current benchmark value for comparable European DMUs. It should also be noted that none of the current designs of European DMUs meet the particular operational requirements for DSB's long-distance Inter-City and inter-regional services. Thus, provided that the IC4 fleet meets its operational objectives, it can be regarded as offering value for money.

The above is a high level assessment based upon information obtained during the period of this Review. A detailed technical and financial study would be required to confirm the actual level of expenditure required and the period over which it should apply, including a breakdown into investment in production capacity, manpower, equipment, and materials.

## 4.2. Planned Entry to Service in Inter-Regional Traffic

There are the following possibilities for the IC4 fleet:-

- introduction to service in long-distance Inter-City and inter-regional services as planned; or
- allocation to regional services only; or
- termination of the contract.

From our review of the status of IC4 trainset deliveries reported in Section 2 above, production of the IC4 fleet is well past the point in time at which it would have been rational to terminate the contract on contractual, technical, or operational grounds. This excludes the third option above.

The lack of alternative viable operational strategies for long-distance Inter-City and inter-regional services (unless there is a political decision to electrify the long-distance DMU routes) and the availability of alternative rolling stock for regional services excludes the second option.

The logical outcome of the above argument is that IC4 should be put into service in long-distance Inter-City and inter-regional services as planned. From our review of current problems, as reported in Section 3 above, and the possibilities for rectification, as reported in Section 4.1 above, we conclude that this is possible.

It follows from this conclusion that IC4PT has to take all necessary steps, and DSB has to provide the necessary resources, to enable the operational objectives for IC4 to be achieved, hence our focus in this Report on increased resources and an aggressive drive for reliability improvement.

Unlike IC4, the IC2 delivery programme is not far advanced and no trainsets have yet been handed over to DSB for modification and putting into traffic. Although type approval may be obtained by December 2011, it is likely that the first trainset will not be delivered to IC4PT until early 2012. Planning for modification of IC2 trainsets is minimal so far and no facilities for a production programme have been identified or prepared.

We consider that the IC2 programme will impact adversely on the IC4 at all stages of the project by distracting management and diverting essential production and technical resources required to achieve the IC4 project objectives. It would be possible to mitigate the impact upon the IC4 programme by deferring IC2 deliveries until all IC4 trainsets have been delivered by AB. However, this would re-introduce the problems of long term storage for the IC2 trainsets. An alternative could be to slow the rate of IC2 production from two trainsets per month to one trainset per month.

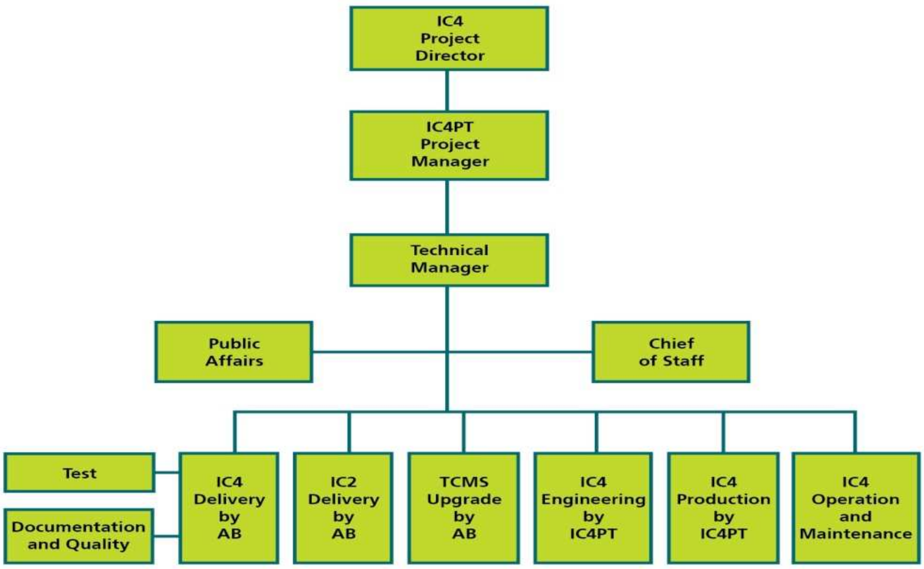
We therefore consider that there is a strong technical argument for termination of the IC2 contract, however it is appreciated that there may be sound legal, commercial and operation reasons for continuing with the project.

We understand that an Operating Strategy Study is being undertaken to develop plans for optimal conditions to introduce the IC4 trainsets to long-distance traffic.

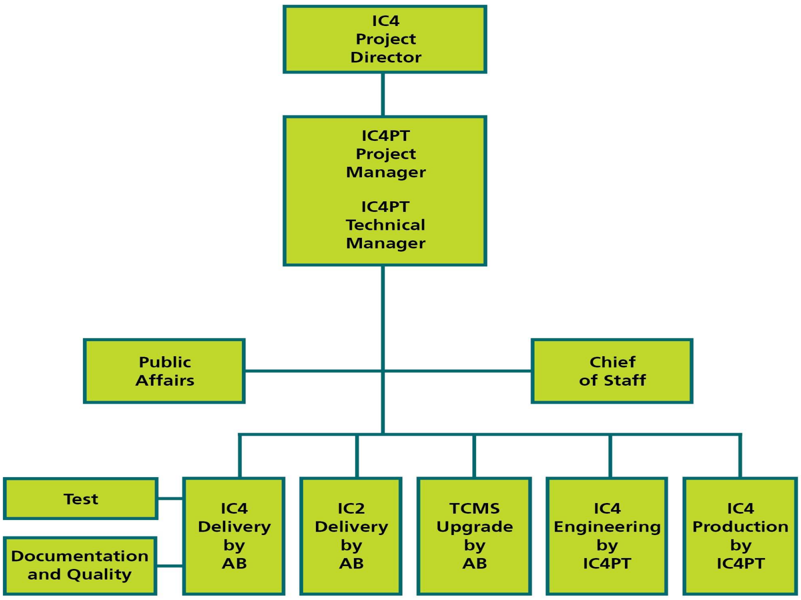
The outcome of the Operating Strategy Study should inform a new Maintenance Strategy Study which should be undertaken to address the concerns identified in Section 3.2.3 above to determine and optimise the locations of maintenance facilities and their capacities and manpower.

## 4.3. IC4 Project Organisation

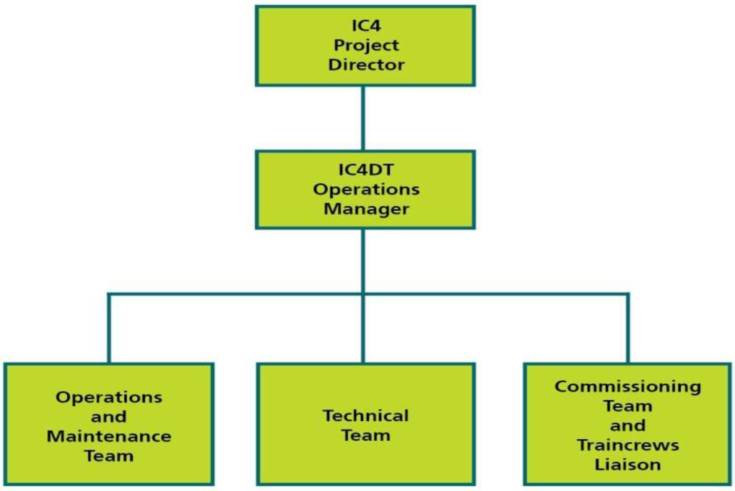
Following the Settlement Agreement in May 2009, the project team was re-organised so as to grow from a purely procurement organisation, responsible for managing the train supply contractor, to an engineering organisation capable of undertaking all the necessary actions to complete the engineering and delivery of the fleet whilst continuing to manage the supply of trainsets from AB. By May 2011, IC4PT had the following structure:-



In May 2011, a new IC4 Drift (Operations) Team was established which incorporated IC4PT's Operation and Maintenance Team together with a new Technical Team and a Commissioning Team under an IC4 Operations Manager. Therefore, since May 2011, the structures of the IC4PT has been:-




While the structure of the IC4DT has been:-

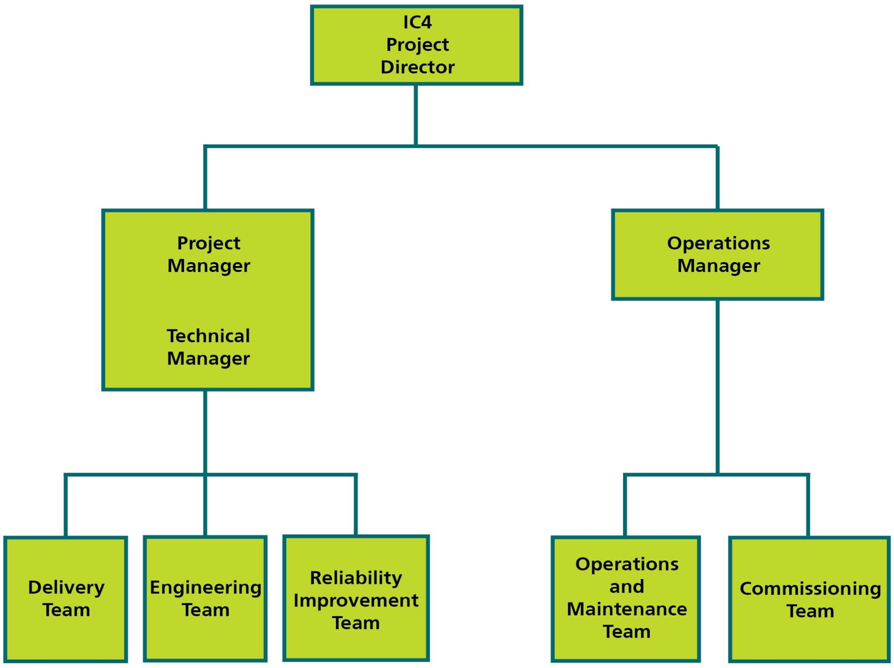



We found all members of the IC4PT that we met or interviewed to be enthusiastic about the project, well motivated, highly competent, and fully committed to achieving delivery of the IC4 programme. Additional engineering staff has been recruited and further recruitment is planned. Even so, it is likely that the enhanced level of resource will still be insufficient to achieve the necessary reliability growth within an acceptable time period as discussed elsewhere in this Report.

The new IC4DT is now responsible for delivering all operating and maintenance requirements for the IC4 fleet including maintenance, trouble-shooting, spares management, technical support, and DTO analysis and reporting. The Team hires blue-collar workers from DSB TM. As the IC4DT was set up only in May 2011, it is still finding its feet and has already established that a further increase in resources with additional capabilities is necessary (URN 191) for a reasonable chance of success in the introduction of the IC4 fleet to traffic.

We consider that the plan to increase IC4DT resources is appropriate and necessary and should be expedited as the number of trainsets available for traffic should increase rapidly from January 2012. We see no requirement to change the structure of the IC4DT organisation except that the Technical Team in IC4DT should be absorbed into the new Reliability Improvement Team in the IC4PT which we have recommended elsewhere in this Report.

However, the establishment of an RIT within IC4PT adds another line report to the IC4PT Technical Manager in what is already a flat organisation. Thus, and in order to achieve a simpler project team organisation which is more manageable and more focused on its key deliverables, we also recommend that the current management responsibilities and functions of the IC4PT are re-grouped. With this change, the Technical Manager will have only three line managers covering delivery, engineering, and reliability improvement as shown below:-




We consider that the three IC4PT technical teams shown above should have the following functions:-

Delivery Team (a grouping of functions currently undertaken in various parts of the present organisation)

- IC4 / IC2 / TCMS Upgrade contract management including commercial and financial aspects
- IC4 delivery by AB
- IC2 delivery by AB
- IC4 production by IC4PT
- IC2 production by IC4PT
- TCMS Upgrade delivery
- Project planning
- Approvals process management
- Production facilities management
- Documentation and quality management

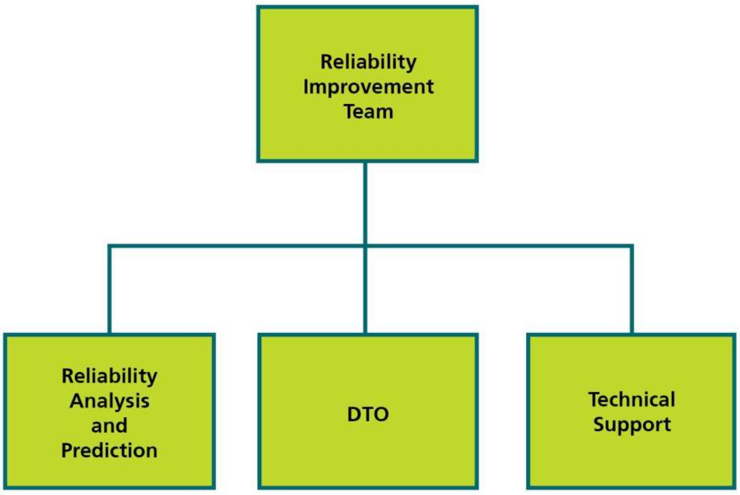
Engineering Team (essentially unchanged from the present organisation)

- Provision of specialist technical expertise to the other IC4PT teams and to IC4DT
- Development of solutions to technical problems
- Design, testing, and verification of CFGs

Reliability Improvement Team (a new team to be established)

- Management of the War Room
- Data logging of technical faults from all input sources
- Data processing and analysis
- Front-line technical support to IC4DT and the operators
- Investigation of root cause of technical faults
- Prioritisation of root causes for remedial actions (in conjunction with other participants)
- Monitoring progress and impact of reliability improvement actions
- DTO interface and preparation of reports
- Preparation of periodic management reports on reliability improvement

We envisage the RIT to have the following structure:-




The proposed structure shown above, together with the scope of responsibilities, interfaces, and staffing level are all further detailed in Section 5.5 below.

# 5. Reliability Improvement

## 5.1. Introduction

### 5.1.1. Principles of Reliability Improvement

There are two fundamental aspects of reliability improvement for all types of traction and rolling stock:-

- reliability improvement is a constant struggle over the entire life of the vehicles; and
- the rate of reduction in failures must outweigh any increase in failures from existing and new issues.

Technical problems emerge from running trains in traffic and are dealt with to create a balance between rising failure rates and the cost and practicalities of implementing reliability solutions. If, broadly, the rate of reduction in failures does not outweigh any increase in failures from existing and new issues then no nett benefit will be achieved and reliability will not improve. Reliability improvement activities should reduce in the future as reliability performance improves, but will remain an on-going requirement at some level for the life of the vehicles.

During the early years of a rolling stock life, when problems are typically high and reliability growth strategy is in its infancy, the train manufacturer will normally assist in driving reliability improvement towards an acceptable balance. This has not happened for IC4 due to the circumstances of the fleet as described in Section 2.1 above. In effect circumstances have combined to the detriment of the reliability of the Units and the IC4PT, as the incumbent train supplier, is faced with an uphill struggle to investigate and implement solutions onto the fleet faster than they arise so that reliability improves to an acceptable level.

This section of the Report provides an overview of Appendix A5 “Reliability Improvement Team - Working Methodology and Implementation” as follows:-

- Section 5.2 covers the current IC4 reliability performance at 1,837 km/casualty.
- Section 5.3 covers the likely benefit of current reliability improvement initiatives which IC4PT have planned or outlined to raise fleet reliability to a predicted value of 5,489 km/casualty.
- Section 5.4 covers the means to achieve reliability improvement by the establishment of a dedicated Reliability Improvement Team.
- Section 5.5 covers the setting of reliability objectives and targets.

### 5.1.2. Safety Related Failures

This section of the Report is focused on providing advice on the introduction of best practice and optimising the measures required to obtain consistent and predictable reliability improvement for the IC4 fleet. However, we recognise that, in the process of tackling all the technical issues that arise, some will have safety related consequences. These safety related failures need to be identified as such, highlighted for prioritisation, and risk assessed as soon as they emerge in a manner which fits their potential impact on safety. Safety mitigations can be pressed forward in parallel with reliability mitigations, however, these issues require consideration of their priority separately from other purely reliability failures.

## 5.2. Current IC4 Reliability Performance

Since their introduction, the fleet of 14 IC4 NT++ trainsets has operated in Regional (local) traffic as single trainsets as they are not approved for operation in multiple. Over this period of operation, their reliability performance has ranged between 1,000 km/casualty and 3,000 km/casualty as measured on a monthly basis. Over the period January 2011 to July 2011, the range was 1,500 km/casualty to 2,800 km/casualty with an average of 2,014 km/casualty which equates to 497 casualties/$10^6$ km.

As stated in Section 3.1.1, the reliability performance of the fleet of 12 MPTO P1 trainsets in traffic from January 2011 to July 2011 has ranged between 1,200 km/casualty and 2,500 km/casualty per month with an average of 1,771 km/casualty which equates to 565 casualties/$10^6$ km.

The further analysis referenced in Section 3.1.1 of 6 MPTO P1 trainsets in traffic from February 2011 to August 2011 records 544 casualties/$10^6$ km which equates to 1,837 km/casualty.

Due to the number of modifications introduced by AB and IC4PT between the NT++ and MPTO P1 design configurations, IC4PT had expected the MPTO P1 trainsets to perform much more reliably than NT++, but these analyses demonstrate that the performance has, so far, been comparable or slightly worse. Indeed, examination of the actual CFGs involved shows that relatively few were designed to impact upon reliability performance and the expectation of an improved performance was therefore unrealistic as has been proved by events.

According to DSB, IC3 performs at around 25,000 km/casualty and between February 2008 and January 2009 the fleet actually operated in excess of 30,000 km/casualty (URN 217). A failure rate of 25,000 km/casualty equates to 40 casualties/$10^6$ km which should be regarded as a benchmark for IC4.

The results of the analyses referred to above are summarised in the following Tables:-

**Table 5.1.A - IC4 Reliability Performance**

| Trainset | Fleet Size | Period | Reliability Performance (km/casualty) | | |
|---|---|---|---|---|---|
| | | | Min | Max | Average |
| IC4 NT++ | 14 | Jan 11 – Jul 11 | 1,500 | 2,800 | 2,014 |
| IC4 MPTO P1 | 12 | Jan 11 – Jul 11 | 1,200 | 2,500 | 1,771 |
| IC4 MPTO P1 | 6 | Feb 11 – Aug 11 | | | 1,837 |
| IC3 | 96 | Feb 08 – Jan 09 | 30,000 | 42,000 | 33,750 |

**Table 5.1.B - IC4 Reliability Performance**

| Trainset | Fleet Size | Period | Reliability Performance (casualty/$10^6$km) | | |
|---|---|---|---|---|---|
| | | | Worst | Best | Average |
| IC4 NT++ | 14 | Jan 11 – Jul 11 | 667 | 357 | 497 |
| IC4 MPTO P1 | 12 | Jan 11 – Jul 11 | 883 | 400 | 565 |
| IC4 MPTO P1 | 6 | Feb 11 – Aug 11 | | | 544 |
| IC3 | 96 | Feb 08 – Jan 09 | 33 | 25 | 30 |

The data presented above shows that the IC4 reliability is poor by any standards, but this is not unusual for new designs of trains when first entering traffic. IC3 itself underwent a long period of development and resolution of teething problems between 1988 and its entry to service in 1991. Indeed, as the systems in IC4 are essentially the same or similar to those on IC3, it would be instructive to examine the reliability records for IC3 from its introduction to traffic and now.

Similarly, DSB's Øresundstog (OTU), which is an electric multiple unit (EMU) developed from the IC3/IR4 family of trains, suffered early reliability problems from its introduction to traffic in 2000. According to DSB data (URN 106), OTU had a reliability level of 2,500 km/casualty in Year 1 which then grew to 17,000 km/casualty over the next 5 years. At the point, the train supplier's warranty obligations ceased and, over the next 2 years, reliability fell to 9,000 km/casualty. Since then, reliability growth has been restored to a current level of 28,000 km/casualty.

Regrettably from a railway industry perspective, the problems recounted above have been experienced by many railway operators and maintainers when new trains are introduced to traffic, although not always from such a low starting point.

In our review of current technical problems with IC4, reported in Section 3.1 above, we have seen no types of fault that are unique to IC4 with the exception of the complex coupling system. It can, therefore, be concluded that the fundamental systems and major items of equipment fitted to IC4 are sound and are currently operating reliably.

However, the available data from existing fault analyses is not adequate for a full assessment of the causes of the current unreliability. What data is available suggests that the high rate of casualties is due to repeat faults (i.e. the same fault or failure mode causing a number of casualties), spurious or inappropriate 'A' alarms to the Driver, incorrect allocation of casualties to failure modes and, with some exceptions, lack of a process to determine root causes on a routine and continuous basis.

At present, fault data analysis is undertaken within the IC4DT, but the methods currently in use require too much human intervention and thus, with limited resources, a routine and coherent output of the root causes of failures and rate of incidence of root causes that impact adversely on operational reliability is not available.

Limited analyses have been undertaken as one-off exercises for the brake system (URN 275) and the Powerpacks (URN 276) and there has been some root cause analysis where rectification CFGs have been identified as reported in Section 3.1 above. In addition, there is the analysis of the performance of 6 MPTO P1 trainsets in passenger service from February 2011 to August 2011, which was undertaken in order to develop a reliability growth prediction following the implementation of Pack 2 and subsequent modifications, and this is considered further in Section 5.2 below.

What is clear is that IC4 reliability, as measured in km/casualty, must be grown substantially and as quickly as is practicably possible for the IC4 fleet to achieve its operational objectives. The requirements and possibilities for reliability growth are addressed in Section 5.2 below.

It follows that reliability growth must now be the top priority for IC4PT and IC4DT together and the main focus for IC4PT management. We therefore recommend the establishment of a separate Reliability Improvement Team (RIT) within IC4PT to provide the focus, resources and methods required to achieve the objectives. The scope of work and organisation of the RIT are set out in Section 5.3 below while the organisational changes that follow from this recommendation are addressed in Section 4.3 above.

## 5.3. Current Rectification Measures for IC4

### 5.3.1. Introduction

The IC4PT has a number of initiatives in various stages of development or implementation which target key causes of current poor reliability. The team have applied estimated reductions to the current reliability statistics to form an overview of how reliability may improve when the initiatives are fully implemented. These various initiatives, or modification programmes, are described in Section 2.2 and the summary Table presented therein is repeated here:-

**Table 5.3.1.A - IC4PT Modifications to IC4 Trainsets**

| Pack | Category | Status |
|---|---|---|
| Pack 1 | Engineering | Completed for 18 MPTO trainsets |
| Package 1 | TCMS Upgrade | Completed for 18 MPTO trainsets |
| Pack 2D | Engineering | To be fitted to 18 MPTO P1 trainsets in Oct/Nov 11 |
| Pack 2A | Engineering | To be fitted to 18 MPTO P2D trainsets at some stage |
| Pack 1+2 | Engineering | Fitted to 2 MPTO trainsets for type approval tests |
| Pack 1+2 | Engineering | To be fitted to all MPTO trainsets from Dec 11 |
| Package 2 | TCMS Upgrade | To be fitted to all trainsets from Oct 11 |

| Pack | Category | Status |
|---|---|---|
| Pack 2.1 | Engineering | In development |
| Pack 2.2 | Engineering | In development |
| Pack 2.3 | Engineering | To be considered |
| Package 3 | TCMS Upgrade | To be considered |

We reviewed the reliability improvement estimation process with IC4DT in order to form an opinion of the prediction technique used and the accuracy of the prediction. IC4DT had assessed the reliability performance of 3 MPTO trainsets from 01 Feb 11 to 31 Jul 11 and produced a reliability improvement prediction for the impact of Packs 2D, 2.1, and 2.2 (URN 277). During our review, this assessment was extended to cover 6 MPTO trainsets from 01 Feb 11 to 31 Aug 11 and a new reliability improvement prediction for the impact of modification Packs 2D, 2.1, and 2.2 was produced (URN 285).

The latter assessment provided the number of casualties reported over the assessment period factored up to an equivalent total of 544 casualties/$10^6$ km together with a breakdown of these casualties into areas covered by CENELEC categories. The 544 casualties/$10^6$ km equates to 1,837 km/casualty with exterior footsteps the source of almost 42% of the casualties.

The predicted impact upon reliability of the various modification packs are reported in the following sections.

### 5.3.2. Implementation of Pack 2D

Pack 2D includes initiatives to improve the reliability of the exterior footsteps which is estimated to reduce footstep failures by 80%. All other reliability improvements offered within Pack 2D provide only minor reliability improvements by comparison.

We consider that the predicted reduction of 80% of footstep failures is realistic given the scope of the work proposed. Thus, the predicted Pack 1 + Pack 2Dd reliability should be approximately 354 casualties/$10^6$ km which equates to 2,820 km/casualty.

### 5.3.3. Implementation of Pack 2.1

The scope of Pack 2.1 is not yet fully defined and the following prediction assumes that the draft plan at the time of producing this Report will be implemented.

Pack 2.1 incorporates reliability improvements to various failures captured in CENELEC categories including the brake system, couplers, HVAC, gearbox control, and air systems. The effective of the improvements to the reliability of these systems is estimated to range from 35% to 50%. The nett impact of these improvements when added to Pack 1 + 2D is predicted to increase reliability to 274 casualties/$10^6$ km which equates to 3,644 km/casualty.

We consider that the predicted improvements are broadly realistic, but comment further on the process used and its likely accuracy in Section 5.3.6 below.

### 5.3.4. Implementation of Pack 2.2

The scope of Pack 2.2 is not yet fully defined. The following assumes that the draft plan at the time of producing this report will be implemented.

Pack 2.2 incorporates further reliability improvements to various failures captured in CENELEC categories including exterior steps, brake system, train control, coupling, HVAC, and the Powerpack. The effectiveness of the improvements to the reliability of these systems is estimated to range from 40 to 50%. The nett impact of these improvements when added to Packs 1 + 2D + 2.1 is predicted to increase reliability to 182 casualties/$10^6$ km which equates to 5,489 km/casualty.

We consider that the predicted improvement is the best approximate estimate that can be made given the quality of the data available at the present time and we comment further on the process used and its likely accuracy in Section 5.3.6 below.

### 5.3.5. Implementation of Pack 2.3

Although some technical issues for which solutions are required have been proposed for Pack 2.3, these have not been defined or agreed as yet and it is therefore not possible to comment on the likely impact of any Pack 2.3.

### 5.3.6. Impact of Current Initiatives on Reliability Performance

The accuracy of the reliability improvement predictions reported in Sections 5.3.2 to 5.3.4 above could be debated at length. Our opinion is that the accuracy of the predictions are likely to lie within a range of +10% to -30%, i.e. the reliability performance resulting from the current planned improvements could be 10% better than predicted or 30% worse. Given that the data used was not processed into root causes, it would be difficult to justify any closer estimate of accuracy. Further details and our proposed improvements for the methods of predicting reliability performance and setting reliability targets to be achieved are presented in Sections 5.4 and 5.5 below.

## 5.4. Reliability Objectives and Setting Reliability Targets

### 5.4.1. Introduction

Due to concerns about falling reliability and punctuality of rolling stock fleets in the UK since privatisation of British Rail in 1994, the UK Association of Train Operating Companies (ATOC) launched a joint initiative in 2002 to spread best practice for improving fleet reliability across all operating companies. This project was referred to as the National Fleet Reliability Improvement Programme (NFRIP) and its key objective was to halve the impact of fleet reliability on operational performance.

By 2010, NFRIP was perceived to have achieved its target and to have reached the point of diminishing returns. Fleet reliability had improved to the point where it was becoming difficult to justify further improvements financially. NFRIP has now the Fleet Reliability Focus Group (Re-focus) which is a resource that can be used by Fleet Management teams on an as required basis.

A major train manufacturer introduced an organisational tool for the on-time production of new rolling stock which they called a “War Room”. When this manufacturer moved into train maintenance in the UK, it introduced the War Room concept into the maintenance depot environment in order to improve the daily depot production activities including reliability improvement. In part due to the activities of NFRIP, this practice has now been adopted by many maintenance depots across the UK.

In this Section of the Report, we make numerous references to the War Room and provide a brief outline of its organisation and activities in Section 5.4 below.

As a direct result of the NFRIP project, all UK rolling stock fleet reliability statistics are published monthly. The data shows that DMUs comparable to the IC4 (but without the complex coupling system) commonly achieve 20,000 km/casualty and, in a few cases, up 70,000 km/casualty. Disparities between reliability data for the same fleets operating on different services mainly depends upon the varying demands and complexities of operations rather than any differences in maintenance practices.

Given the range of passenger services in which IC4 is to operate and the relative complexity of those operations, an ultimate reliability performance in excess of 20,000km/casualty is a realistic target for IC4PT to aim at achieving. Apart from the coupling system, no other technical issue has emerged during our review that would suggest that the IC4 fleet should not be capable of achieving this target.

### 5.4.2. Targets for Reliability Improvement over Time

Given the results of our review as presented above and elsewhere in this Report, we consider that the reliability targets presented in Figure 5.4.2.A below are realistic and, indeed, are necessary.

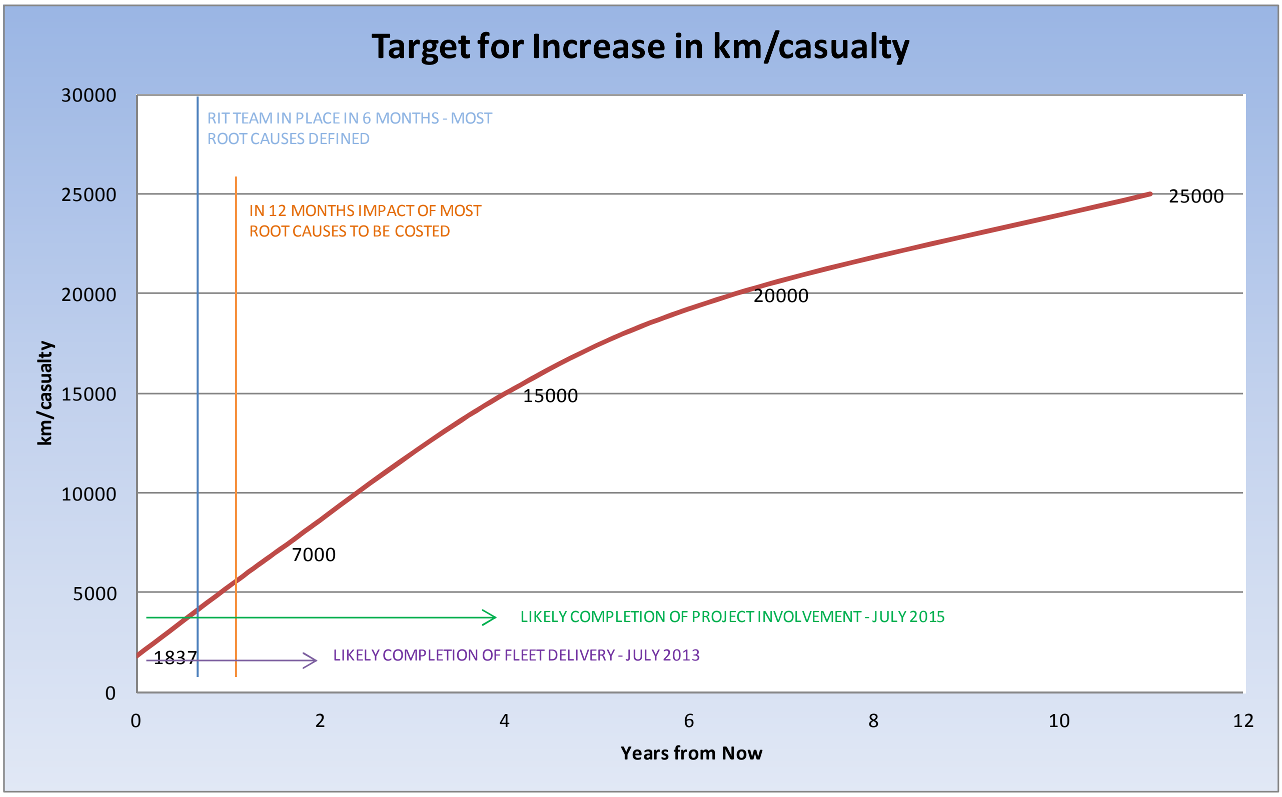



**Fig. 5.4.2.A - IC4PT Reliability Improvement Targets**

The graph indicates the required reliability growth from the current performance level of 1,837 km/casualty to a target of 15,000 km/casualty in 4 years from now by October 2015 and 20,000 km/casualty in 6½ years from now by April 2018.

In reality, the progress made towards achieving these overall goals is likely to be achieved as stepped improvement as the various reliability initiatives are developed and implemented. The curve of improvement will always flatten as the fleet approaches the level of optimum reliability due to the law of diminishing returns. Whilst the RIT team is being organised over the next 6 months, the rate of improvement attained may trail the above curve, but a rapid deployment of this team would help to reduce the lag.

The current reliability improvements detailed previously should continue to be implemented as planned. Since the detail and timescales of some of the improvements leading up to a predicted improvement of 5,489 km/casualty are not clear, these intermediate improvement stages have not been included in the above graph.

The RIT team should use a model similar to that shown above as a benchmark for monitoring the achievement of actual reliability improvements.

In parallel with implementing the current reliability improvements, the RIT team and the War Room should be created as soon as possible to be fully functional, including recruitment and the development and commissioning of improved data processing and storage capabilities, within 6 months from now.

IC4PT should employ an external Technical Advisor with experience of implementing such measures for this initial build-up period during which the team should be tasked with defining root causes for the majority of arising casualties. The fully formed team should then be expected to have increased the proportion of defined root causes and should aim to have the cost impact of most root causes established within a further 6 months from now.

The objective timescales for achieving the reliability targets presented in Fig. 5.4.2.A above are likely to be the most difficult point to achieve a common agreement within DSB. Targets set should be realistically achievable but challenging, recognising that opinions regarding achievable targets are likely to vary considerably.

Our discussions with IC4PT regarding their perception of the time required to implement a simplified coupling system highlighted this issue. Estimates of 2 to 3 years were put forward, whereas we would expect such a modification to be engineered and approved within 6 months and implemented over a further 6 months. Achieving such challenging targets with similar initiatives in a timely manner is the key to sustained reliability growth.

The War Room environment should seek to drive timescales to meet reliability targets. Should predicted increases in reliability significantly trail reliability objectives, higher management can be asked to attend the War Room to help prioritise and adjust resources as required to meet the declared objectives.

### 5.4.3. Individual Reliability Targets and Key Performance Indicators (KPIs)

To achieve a reliability performance of 15,000 km/casualty or 67 casualties/$10^6$ km en route to an ultimate objective in excess of 20,000 km/casualty or less than 50 casualties/$10^6$ km, the RIT need to set objectives for the reduction of individual root causes of the various failure modes.

We consider that it is important to translate reliability targets into individual objectives for the control of each root cause (and System if appropriate) and set up a working environment where these individual targets and the progress towards achieving individual and overall targets are clearly visible to all. These targets should be agreed by all and should then become the goal of all the parties that can influence their achievement. It is recommended that individual root cause targets and their combined total (the actual fleet reliability) are suitable KPIs to be displayed on the War Room wall.

Reliability targets can be set for permissible periodic numbers of casualties and these targets monitored on an individual basis. Assuming that the post Pack 2.2 reliability prediction of 182 casualties/$10^6$ km is accurate, the targets from this point onwards need to focus on a further 73% net reduction in failure rates to achieve the objective of 20,000 km/casualty or 50 casualties/$10^6$ km.

Other KPIs which should be considered for display on the War Room wall are:-

- Rate of arising new root causes of technical faults.
- Sum total of all casualties for which no fault has been found, their impact on fleet reliability, and how these ‘No Fault Found’ (NFF) failures break down into train systems or components.
- Sum total of all non-technical faults, their impact on fleet reliability, and how these faults break down into train systems or components.
- Percentage of known root causes with respect to all technical faults.
- Time taken to progress faults from root cause identification through all stages to the completion of applied mitigations, i.e. the time taken for reliability issues to complete the cycle shown in Section 5.4.1 below.

## 5.5. Reliability Improvement Team and War Room Activities

### 5.5.1. Reliability Improvement

The purpose of the War Room is to provide control and optimisation of the cycle of reliability improvement.

Improving reliability is a cyclical process which, in a simplified form, captures and monitors arising fault data, identifies root causes, processes and prioritises the fault data, identifies potential modifications or other improvements, justifies and seeks authority for the optimum improvement, implements the modification or other improvement, and monitors the effectiveness of the implemented improvement. This cycle is represented in the form shown in Fig. 5.5.1.A below to emphasise that it is a continuous process which requires considerable effort and will to keep turning:-

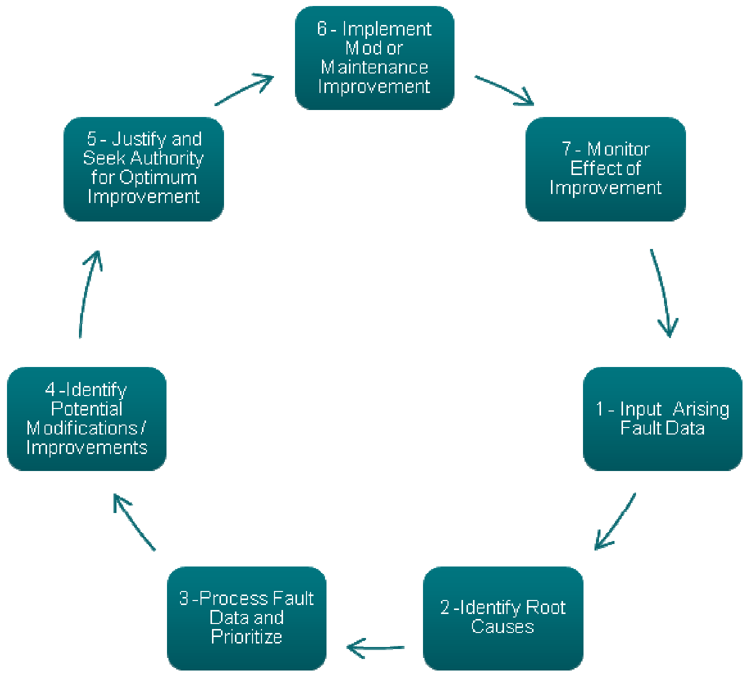



**Fig. 5.5.1.A - Reliability Improvement Cycle**

This process is not solely contained within the activities of the RIT. The purpose of the War Room is to bring all contributing parties together and to co-ordinate all their activities towards achieving the agreed reliability goals. It is recommended that reliability meetings take place in the War Room itself at least every two weeks.

A fully-detailed representation of the processes, activities, and data flows involved in reliability improvement and the use of a War Room are shown overleaf in Fig. 5.5.1.B.

### 5.5.2. RIT and War Room Process Objectives

To achieve reliability improvement, the war room function must bear in mind the following process objectives:-

- The speed of completing the cycle of implementing improvements dictates the rate of reduction in failures. The deadlines set within the War Room must reflect the need for reliability growth. The RIT must monitor progress towards achieving deadlines so as to ensure that they remain on target.
- The rate of reduction in failures must outweigh the increase in failures from existing and new issues for any nett benefit to be achieved. Predictions should be made showing improvements in future periods against the targets with an allowance for new issues arising.
- The rate of failure for some root causes will be controlled by the implementation of future heavy maintenance and overhaul tasks. War Room activities must link into plans for overhaul programmes.
- As reliability improves, the selection of priorities and justification of expenditure for improvements becomes more difficult. The cost emanating from each root cause needs to be defined to feed into cost benefit estimates for proposed rectifications.

### 5.5.3. RIT Responsibilities

The RIT should be responsible for:-

- setting up and running the reliability improvement programme;
- setting up and running the War Room;
- driving a consistent and rapid programme of reliability improvement;
- continuous assessment of train operating, reliability, and technical data;
- interfacing with DTO and the production of DTO reports;

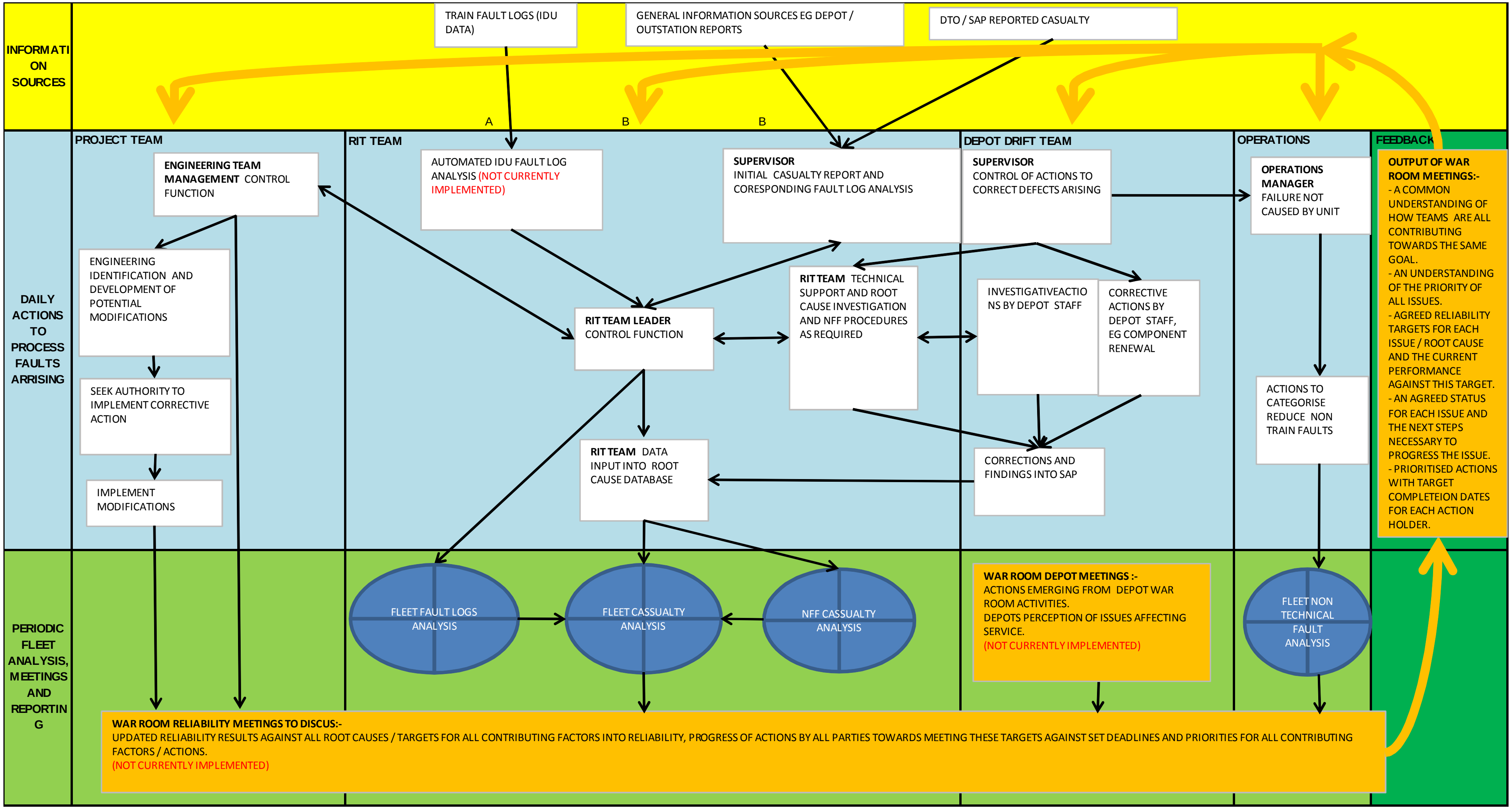



**Fig. 5.5.1.B - IC4 Reliability Improvement Process Flow Chart**

- continuous process of fault monitoring using a database and automated algorithms;
- continuous process of fault analysis to determine root causes using a database and automated algorithms;
- providing front-line technical support to the maintenance depot and to operators;
- continuous ranking of root causes to inform external decisions (i.e. external to the RIT but within IC4PT with other interested parties) on the prioritisation of resources including manpower, materials, facilities, and time to develop and implement solutions;
- continuous monitoring of progress with the implementation of rectification actions;
- continuous measurement of the effectiveness of rectification actions on reliability performance;
- prediction of reliability growth and setting reliability improvement targets to IC4PT and IC4DT; and
- production of reliability improvement management reports.

### 5.5.4. Reliability, Availability, Maintainability, and Safety (RAMS)

RAMS is an acronym for the term "Reliability, Availability, Maintainability and Safety" as defined in CENELEC Euronorm EN 50126. It provides a structured approach and methodology for achieving RAMS objectives and is widely used in safety critical environments including in the rail industry. It can be used in the development and introduction of new products and also in the planning and implementation of new systems. RAMS management ensures that systems are defined, risk analyses are performed, risk rates are determined, and safety cases prepared.

The goals of safety and availability in an operation can only be realised if the reliability and maintainability requirements and the constantly on-going long-term maintenance and operational environment is monitored. Availability depends upon knowledge of the reliability based on system failure rate analysis, analysis of potential hazards via Hazard and Operability Studies), the probability of occurrence of a failure by fault tree analysis, the effect of a failure on the functionality of a system by means of a Failure Modes and Effects Analysis (FMEA), and on knowledge of maintainability based on repair times. The RAMS process should continue throughout the life of the operation.

In the case of IC4, the proposed RIT should focus primarily on reliability and safety. Availability of trainsets for traffic is generally controlled by daily maintenance depot activities, although an acceptable reliability performance should ensure an acceptable availability as the two are intrinsically linked. However, low availability can put pressure on a maintenance depot to release trainsets into traffic before the optimum level of work is achieved to minimise reliability issues. Thus, whilst the RIT would not lead the pursuit of daily availability targets, also typically held in a War Room, they would take an active interest in ensuring that, as far as practicable, all work to minimise reliability had been achieved before units are released to traffic in a condition where repeat failures could occur.

Maintainability is a RAMS activity predominantly pursued during the design phase of a new fleet. Major improvements to maintainability are difficult to achieve when a fleet has been introduced, but the RIT should have a major input into routine and overhaul maintenance. These activities must be focused on achieving maintenance which is geared towards capturing potential failures during routine maintenance and overhauling components to a standard and in a timeframe which promotes reliability.

### 5.5.5. War Room Operation and Layout

A War Room is typically a room without furniture with wall mounted displays showing performance, objectives, actions, action holders, and planned dates for actions to be completed. War Room meetings should be hosted by the RIT team at least every two weeks, more often if necessary, and should be attended by those parties directly involved with achieving the agreed targets including representatives from the following as a minimum:-

- IC4DT
- IC4PT Engineering
- Operations (Traffic department)
- IC4PT’s internal DSB customers to provide witness and overview comments

Within the next 6 months, the RIT should endeavour to ensure that the majority of all arising failures are categorised with a root cause. In the following 6 months, the RIT should seek to improve on this and to extend the recording of failures within each root cause to include an estimation of the cost/benefit that would be result from implementing a solution. The latter will be required as reliability increases and finding cost effective improvements becomes more and more difficult to achieve. A brief cost/benefit analysis can be conducted for each root cause to demonstrate that the available investment to improve reliability is being expended wisely with maximum impact for the investment.

The RIT Team Leader should ensure that an overview of the current status of reliability is displayed on the War Room walls against the objective set for each root cause and should drive discussions to focus on this objective.

The IC4PT engineering representatives attending War Room meetings would have the opportunity to discuss the progress of initiatives in hand to improve reliability, the performance of previously implemented improvements against objectives, and the priority of problems for which there is as yet no planned resolution.

The Operations (Traffic) representatives should be present to discuss a similar set of points for failures not directly arising from train failures and to provide feedback for all technical and non-technical faults back to their own organisation. The latter failures should not be ignored as they can be a significant part of overall fleet reliability, particularly during the early stages of a fleet's life.

The IC4DT representatives should attend to discuss the impact of maintenance depot activities on fleet reliability including for example maintenance initiatives to improve reliability.

The RIT should ensure that defects for which no fault has been found are discussed and driven separately within the War Room. These faults may be technical or non-technical faults for which the resolution may involve a different course of action to typical known technical faults.

IC4PT's internal DSB customers could be periodically invited to War Room discussions to witness the progress being made and to provide their opinion of the direction and focus of the War Room discussions. Periodic customer involvement in the process can greatly aid a common understanding of issues, progress, and the way forward which the production of periodic management reports cannot achieve.

### 5.5.6. Setting Reliability Targets

As mentioned elsewhere in this report, we consider that technical failures must be grouped into root causes to drive reliability improvement effectively. This provides many benefits including the prediction of future reliability. Grouping technical failures and their respective impact on operational stability into root cause categories provides the best possible quantification of each issue and ensures that each issue is prioritised according to its impact upon operational stability. This is not currently the case. At present, technical faults are categorised under CENELEC codes which in some cases contain many different and unrelated root causes. Estimating the improvement of a reduction or elimination of an individual root cause is therefore more difficult and is inherently biased towards a perceived estimate instead of factual data.

Once each root cause of failure is separated out, it becomes easier to monitor trends in past reliability and therefore to predict future trends. Understanding the root cause can often aid predicting how reliability issues are likely to change. For example, assuming that the failure rates of technical issues are constant can produce a false prediction for a number of reasons. New technical problems emerge, particularly during the early periods of a fleet's life span, but if root causes are being recorded then the rate of new problems emerging can also be determined which provides the best indication of the potential impact of new problems.

### 5.5.7. Staffing Requirements

The integration of a new fleet into service is normally supported by the fleet manufacturer. It would be common for a team of up to 50 individuals to support the fleet through the early stages of delivery, commissioning, and entry into traffic. Some of the train manufacturer's on-site team would be focussed primarily on reliability improvement and tasked with achieving project defined reliability targets with the support of the manufacturer's own engineers and those of sub-suppliers within a warranty period. This has not happened with IC4 and, in effect, the RIT needs to become a replacement for this activity and to fulfil the commitment which is typically carried out by the train manufacturer.

The proposed structure of the RIT is shown in Section 4.3 above and the staffing requirements are considered to comprise:-

**Table 5.5.7.A - RIT Staffing Requirement**

| Function | Initial Staffing | Future Staffing |
|---|---|---|
| Team Leader | 1 | 1 |
| Technical Support<br>(root cause investigation and front-line technical support to IC4DT and Operators) | 3 | 2 |
| Data Processing and Analysis | 2 | 1 |
| Reliability Improvement Prediction and Target Setting | 1 | 1 |
| DTO | 1 | 1 |
| Total establishment | 8 | 6 |

We consider that this level of staffing is required to overcome the current volume of faults and their rectification and to drive reliability improvement over the next 2 to 3 years. The RIT, the War Room, and the required data processing capabilities should all be fully established within 6 months from now.

As the reliability of the fleet increases and the number of new or unresolved technical issues decreases, it should be possible to reduce the staffing requirement by at least two members as shown in Table 5.5.7.A above. The RIT is likely to be required for a longer period than the IC4PT and should, at an appropriate juncture, be integrated into the maintenance organisation.

# 6. Conclusions

The purpose of this Background Report is to record the methodology of our Review and the detailed factual support for our findings, conclusions, and recommendations. These can be found in our IC4/IC2 Review Summary Report ref. 5105273.001/001.

# 7. Appendices

A1 Glossary of Terms

A2 Schedule of Meetings, Interviews, and Visits

A3 Documentation

A4 Question / Answer Log

A5 Reliability Improvement Team - Working Methodology and Implementation

# A 1 Glossary of Terms

In this Report the following terms are used:-

| | |
|---|---|
| AB | AnsaldoBreda, Italy |
| ARG | Axle Reversing Gear |
| AT | Atkins (Danmark and UK) |
| ATOC | Association of Train Operating Companies |
| BCU | Brake Control Unit |
| CCU | Train Computer (part of TCMS) |
| CENELEC | Comité Européen de Normalisation Électrotechnique (European Committee for Electrotechnical Standardisation |
| CFG | Modification Instruction |
| DLU | Data Logging Unit |
| DMMU | Diesel-Mechanical Multiple Unit |
| DMU | Diesel Multiple Unit |
| DSB | Danske Statsbaner (Danish State Railways), Danmark |
| DSB TM | DSB Train Maintenance (DSB Vedligehold A/S) |
| DSD | Driver's Safety Device (Dødmandspedalen) |
| DTO | DSB train reliability monitoring system |
| EMU | Electric Multiple Unit |
| FMEA | Failure Modes and Effects Analysis |
| GTA | Good Trains for All |
| HVAC | Heating, Ventilation, and Air Conditioning |
| IC2 | 2-car Inter-City diesel-mechanical multiple unit train designed and manufactured by AB |
| IC3 | 3-car Inter-City diesel-mechanical multiple unit train designed by DSB and ABB Scandia (now Bombardier Transportation), manufactured by ABB Scandia, and introduced to traffic in 1991 |
| IC4 | 4-car Inter-City diesel-mechanical multiple unit train designed and manufactured by AB |
| IC4DT | IC4 Operations Team |
| IC4PT | IC4 Project Team |
| IDU | Integrated Diagnostic Unit (TCMS human-machine interface in each driving cab) |
| IFE | Innovationen Für Einstiegssysteme (door supplier, based in Austria) |
| ISA | Independent Safety Assessor |
| KPI | Key Performance Indicator |
| LTS | Long Term Storage |
| MPTO | An IC4 train design configuration for limited multiple train operation |
| MPTO P1 | An IC4 train design configuration for 2 trainset multiple train operation and fitted with Pack 1 modifications by DSB |
| MPTO P2 | An IC4 train design configuration for 3 trainset multiple train operation and fitted with Pack 1+2 modifications by DSB |
| MSR | Cab-to-shore radio system |
| NFF | No Fault Found |
| NFRIP | National Fleet Reliability Improvement Programme |
| NT | National Traffic |
| NT++ | An IC4 train design configuration capable of operating on NT services through the Great Belt tunnel |

| | |
|---|---|
| OFV | Officine Ferroivarie Veronese |
| PIS | Passenger Information System |
| RAMS | Reliability, Availability, Maintainability and Safety |
| RIO | Coach Computer (part of TCMS) |
| RIT | Reliability Improvement Team |
| RTR | Restricted Test Running |
| SAP | Systemanalyse und Programmentwicklung (supplier of spare parts management software) |
| SPM | Scheduled Preventive Maintenance |
| TCMS | Train Control and Management System |
| TRIT | Tele og Radioinformationssystem i Tog (Telecommunications and Radio Information in the Train) |
| TRM | Transportministeriet (Ministry of Transport), Danmark |
| TS | Trafikstyrelsen (National Safety Authority), Danmark |
| UCM | Unscheduled Corrective Maintenance |
| URN | Unique Reference Number |
| WSP | Wheels Slip/Slide Protection |

# A 2 Schedule of Meetings, Interviews, and Visits

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 28-Jun-11 | Inception Meeting<br>IC4 Steering Group<br>Transportministeriet<br>København<br>Danmark | Lasse Winterberg - TRM<br>Kim Pimenta - TRM<br>Leif Funch - TS<br>Torben Kronstam - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Introduction of Steering Group to Atkins Project Team.<br>Discussion of Project Remit, Atkins proposed approach, and presentation of amended project plan. |
| 29-Jun-11 | Meeting<br>DSB<br>København<br>Danmark | Torben Kronstam - DSB<br>Janie Behrensdorff - DSB<br>Steffen Ingerslev Knudsen - DSB<br>Bent Van - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Introduction to project by Torben Kronstam and overview of project background and history. Introductions to members of his Team covering quality management, mechanical engineering, electronics, type approval, and systems project management and to Bent Van who covers internal DSB technical approval. |
| 29-Jun-11 | Interview<br>DSB<br>København<br>Danmark | Steffen Ingerslev Knudsen - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Quality System Management. |
| 30-Jun-11 | Meeting<br>DSB<br>København<br>Danmark | Janie Behrensdorff - DSB<br>Steffen Ingerslev Knudsen - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | AT tabled a list of documentation required for review. |
| 30-Jun-11 | Interview<br>DSB<br>København<br>Danmark | Torben Kronstam - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Train delivery by AB. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 30-Jun-11 | Interview<br>DSB<br>København<br>Danmark | Steffen Ingerslev Knudsen - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Quality System Management (continued from 29 Jun 11). |
| 30-Jun-11 | Interview<br>DSB<br>København<br>Danmark | Carsten Sartori - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Passenger Information System. |
| 04-Jul-11 | Meeting<br>DSB<br>København<br>Danmark | Torben Kronstam - DSB<br>Lars Slott Jensen - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Train design configurations, train deliveries, train reliability, technical issues, and train type approvals. |
| 05-Jul-11 | Meeting<br>TS<br>København<br>Danmark | Leif Funch - TS<br>Katrine Frellsen - TS<br>Joakim Böcher - TS<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT | Train type approval process and history. |
| 06-Jul-11 | Meeting<br>DSB<br>Århus<br>Danmark | Torben Kronstam - DSB<br>Jens Michael Toft - DSB<br>Keld Eriksen - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT<br>Paul Finnegan - AT | IC4 project team organisation at Århus, technical change process including a review of the process for an example CFG, NT train performance, open issues at handover from AB to DSB, key technical issues, spares requirements, and IC2 planned delivery. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 06-Jul-11 | Meeting<br>DSB<br>Århus<br>Danmark | Torben Kronstam - DSB<br>Hans Jacob Sørup Jacobsen - DSB<br>Jes A Nielsen<br>Benni H Nissen - DSB<br>Flemming Vestergaard Jensen - DSB<br>Johan Stranddorf - AT<br>Nick Brown - AT<br>Keith Paling - AT<br>Paul Finnegan - AT | DSB operations and maintenance organisation and its relationship with the IC4 / IC2 project, train reliability, fault reporting system, train type approval and entry to traffic. |
| 07-Jul-11 | Visit<br>DSB<br>Århus<br>Danmark | Hans Jacob Sørup Jacobsen - DSB<br>Benni H Nissen - DSB<br>Flemming Vestergaard Jensen - DSB<br>Nick Brown - AT<br>Keith Paling - AT<br>Paul Finnegan - AT | Tour of the IC4 depot facilities and review of an IC4 train set. |
| 07-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Flemming Vestergaard Jensen - DSB<br>Paul Finnegan - AT | Operator's train fault reporting system (DTO), depot reporting system (SAP), train reliability data, and technical issues. |
| 07-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Benny H Nissen – DSB<br>Poul Pedersen - DSB<br>Paul Finnegan - AT | Depot reporting system (SAP) and spares supply management (demand, ordering, storage). |
| 07-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Hans Jacob Sørup Jacobsen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | Technical issues, technical solutions, spares supply, and resources. |
| 07-Jul-11 | Conference Call<br>DSB<br>Århus<br>Danmark | Ken Busk – DSB (in Copenhagen)<br>Jens Michael Toft – DSB<br>Flemming Vestergaard Jensen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | AB delivery programme. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 20-Jul-11 | Meeting<br>AB<br>Pistoia<br>Italy | Roberto Pecchioli – AB<br>Stefano Gambaro – AB<br>Carlo Micchetti - AB<br>Lars Slott Jensen – DSB<br>Nick Brown – AT<br>Keith Paling – AT | IC4 / IC2 Project from AB's perspective – AB presentation to AT. |
| 21-Jul-11 | Interview<br>AB<br>Pistoia<br>Italy | Roberto Pecchioli – AB<br>Stefano Gambaro – AB<br>Lars Slott Jensen – DSB<br>Nick Brown – AT<br>Keith Paling – AT | IC4 / IC2 Project from AB's perspective – questions by AT. |
| 21-Jul-11 | Visit<br>AB<br>Pistoia<br>Italy | Roberto Pecchioli – AB<br>Stefano Gambaro – AB<br>Carlo Micchetti - AB<br>Lars Slott Jensen – DSB<br>Nick Brown – AT<br>Keith Paling – AT | Tour of IC4 production facilities at Pistoia. |
| 21-Jul-11 | Interview<br>AB<br>Pistoia<br>Italy | Roberto Pecchioli – AB<br>Stefano Gambaro – AB<br>Carlo Micchetti – AB<br>Nicola Meini - AB<br>Lars Slott Jensen – DSB<br>Nick Brown – AT<br>Keith Paling – AT | RCM (reliability centred maintenance) and LCC (life cycle cost) model. |
| 27-Jul-11 | Interview<br>AB<br>Augustenborggade<br>Århus<br>Danmark | Roberto Pecchioli – AB<br>Carlo Micchetti – AB<br>Nick Brown – AT<br>Keith Paling – AT | AT questions arising from meetings in Pistoia on 20-21-Jul-11. |
| 27-Jul-11 | Visit<br>AB<br>Augustenborggade<br>Århus | Roberto Pecchioli – AB<br>Carlo Micchetti – AB<br>Nick Brown – AT<br>Keith Paling – AT | Tour of IC4 commissioning facilities. |

| | | | |
|---|---|---|---|
| | Danmark | | |
| **Date** | **Title**<br>**Location** | **Present** | **Purpose** |
| 27-Jul-11 | Visit<br>DSB TM<br>Randers<br>Danmark | Anders Hylleberg - DSB<br>Benny Knudsen – DSB TM<br>Roberto Pecchioli – AB<br>Carlo Micchetti – AB<br>Michael Franchitti - AB<br>Nick Brown – AT<br>Keith Paling – AT | Tour of IC4 NT train upgrade facilities. |
| 27-Jul-11 | Meeting<br>DSB TM<br>Randers<br>Danmark | Anders Hylleberg - DSB<br>Benny Knudsen – DSB TM<br>Roberto Pecchioli – AB<br>Carlo Micchetti – AB<br>Michael Franchitti - AB<br>Nick Brown – AT<br>Keith Paling – AT | IC4 NT train upgrade programme. |
| 28-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Keld Eriksen - DSB<br>Alan Victor Jensen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | IC4 modification programme, plans, resources, working relationships. |
| 28-Jul-11 | Visit<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen - DSB<br>Hans Jacob Sørup Jacobsen - DSB<br>Benni H Nissen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | Coupling demonstration using IC4 train sets 41 and 42. |
| 28-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen - DSB<br>Hans Jacob Sørup Jacobsen - DSB<br>Jes A Nielsen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | IC4 preventive and corrective maintenance and IC4 Drift team resources and capacity. |
| 29-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen - DSB<br>Benni H Nissen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | IC4 spare parts management and supply. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 29-Jul-11 | Interview<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen - DSB<br>Steen L Andersen - DSB<br>Nick Brown - AT<br>Keith Paling - AT | IC4 DTO reliability reporting, analysis, and technical issues. |
| 02-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Keith Paling - AT | AT questions arising from previous meetings, interviews, and documentation. |
| 02-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Allan Victor Jensen - DSB<br>Keith Paling - AT | Technical issues and CFGs. |
| 02-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Inge Brandbye - DSB<br>Keith Paling - AT | TCMS upgrade programme, delivery, and technical issues. |
| 03-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Anders Hylleberg - DSB<br>Johan Stranddorf - AT<br>Keith Paling - AT | Financial status of the IC4 / IC2 project including the Settlement Agreements and the TCMS Upgrade contract. |
| 03-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Anders Hylleberg - DSB<br>Johan Stranddorf - AT<br>Keith Paling - AT | DSB's response to AB's presentation to AT in Pistoia on 20-Jul-11. |
| 03-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Johan Stranddorf - AT<br>Keith Paling - AT | AT questions arising from previous meetings, interviews, and documentation. |
| 04-Aug-11 | Interview<br>DSB<br>København | Lars Slott Jensen - DSB<br>Anders Hylleberg – DSB<br>Ken Busk - DSB | IC4 quality. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| | Danmark | Keith Paling - AT | |
| 04-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Ken Busk - DSB<br>Keith Paling - AT | IC4 and IC2 AB delivery programmes. |
| 04-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen - DSB<br>Keith Paling - AT | Final round-up of AT questions arising from previous meetings, interviews, and documentation. |
| 05-Aug-11 | Interview<br>DSB<br>København<br>Danmark | Frank Olesen<br>Lars Slott Jensen – DSB<br>Johan Stranddorf – AT<br>Helge Bay - AT<br>Keith Paling – AT | IC4 / IC2 operating strategy and other operating issues. |
| 08-Aug-11 | Interview<br>TS<br>København<br>Danmark | Leif Funch - TS<br>Katrine Frellsen - TS<br>Joakim Böcher - TS<br>Johan Stranddorf - AT<br>Keith Paling - AT | Train type approval process and history including running permits. |
| 09-Aug-11 | IC4 Steering Group<br>Transportministeriet<br>København<br>Danmark | Lasse Winterberg - TRM<br>Kim Pimenta - TRM<br>Leif Funch – TS<br>Frank Olesen - DSB<br>Torben Kronstam - DSB<br>Johan Stranddorf - AT<br>Keith Paling - AT | Progress report by Atkins. |
| 30-Aug-11 | Meeting<br>Transportministeriet<br>København<br>Danmark | Claus F. Baunkjær - TRM<br>Lasse Winterberg - TRM<br>Kim Pimenta - TRM<br>Johan Stranddorf - AT<br>Keith Paling - AT | Statement by Atkins on the current status of the IC4 and IC2 projects. TRM requested Atkins to undertake some further review and investigations as Phase 2 of the assignment. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 31-Aug-11 | Meeting<br>Atkins<br>København<br>Danmark | Torben Kronstam - DSB<br>Lars Slott Jensen - DSB<br>Flemming Vestergaard Jensen - DSB<br>Johan Stranddorf - AT<br>Keith Paling – AT | Review Phase 2 and questions relating to DSB production facilities, IC2 production and approval, DTO reports, and technical issues. |
| 06-Sep-11 | Interview<br>DSB<br>København<br>Danmark | Lars Slott Jensen – DSB<br>Søren Juhl - DSB<br>Keith Paling - AT | IC2 production and delivery by AB and DSB. |
| 06-Sep-11 | Meeting<br>DSB<br>København<br>Danmark | Lars Slott Jensen – DSB<br>Steffen Ingerslev Knudsen - DSB<br>Keith Paling – AT | Reliability improvement. |
| 06-Sep-11 | Meeting<br>DSB<br>København<br>Danmark | Torben Kronstam – DSB<br>Lars Slott Jensen – DSB<br>Anders Hylleberg - DSB<br>Keith Paling – AT | DSB IC4 production facilities, plans for Pack 2 fitment to the IC4 fleet, operating simulation, and planning for Atkins to visit Århus. |
| 08-Sep-11 | Meeting<br>DSB<br>København<br>Danmark | Lars Slott Jensen – DSB<br>Mikael Obelitz – DSB<br>Nils Peter Næstrup Sørensen<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Technical Problems - Task 2b Axle Reversing Gear (ARG) and IDU Filter. |
| 09-Sep-11 | Interview<br>DSB<br>Århus<br>Danmark | Flemming Vestergaard Jensen – DSB<br>Erik Just - DSB<br>Jens Michael Toft – DSB (part time)<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Reliability Improvement - Task 1a. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 12-Sep-11 | Interview<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen – DSB (part time)<br>Flemming Vestergaard Jensen – DSB<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Reliability Improvement - Task 1a (continued). |
| 12-Sep-11 | Meeting<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen – DSB<br>Flemming Vestergaard Jensen – DSB<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Reliability Improvement - Task 1b. |
| 13-Sep-11 | Meeting<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen – DSB (part time)<br>Jens Michael Toft – DSB<br>Flemming Bach Tomassen – DSB<br>Niels Nielsen - DSB<br>Jakop Bisgård – DSB<br>Ole Mårtensson – DSB<br>Flemming Vestergaard Jensen – DSB<br>Nick Brown - AT<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Technical Problems - Task 2a and Task 2b Compressors, Battery Chargers, HVAC, Brake System, and Coupling System. |
| 14-Sep-11 | Meeting<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen – DSB (part time)<br>Mikael Obelitz – DSB<br>Flemming Bach Tomassen – DSB<br>Niels Nielsen – DSB<br>Morten Ellerman - DSB<br>Kai O Mogensen – DSB<br>Ole Mårtensson – DSB<br>Niels Peter Nåstrup - DSB<br>Flemming Vestergaard Jensen – DSB<br>Nick Brown - AT<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Technical Problems - Task 2a Door & Footstep System. |

| Date | Title<br>Location | Present | Purpose |
|---|---|---|---|
| 15-Sep-11 | Meeting<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen – DSB (part time)<br>Ole Nielsen – DSB<br>Flemming Vestergaard Jensen – DSB<br>Nick Brown - AT<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Technical Problems - Task 2c Other Technical Issues. |
| 15-Sep-11 | Meeting<br>DSB<br>Århus<br>Danmark | Lars Slott Jensen – DSB (part time)<br>Flemming Vestergaard Jensen – DSB<br>Nick Brown - AT<br>Keith Paling – AT<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Reliability Improvement - Task 1a (continued). |
| 16-Sep-11 | Meeting<br>DSB<br>Århus<br>Danmark | Flemming Vestergaard Jensen – DSB<br>Paul Finnegan - AT | IC4/IC2 Review Phase 2: Reliability Improvement - Task 1b (continued). |

# A 3 Documentation

| Source | Document Ref. | Document Title | Format | Rev | Date | By | Date Received | URN | Category | Document Content |
|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | DTO Monthly Meeting IC4 March 2011 | hard doc | | 18-Apr-11 | DSB | 29-Jun-11 | **001** | Reliability | Notes of DTO Monthly Meeting - March 2011. |
| DSB | | DTO Conclusions March 2011 | hard pdf | | 15-Apr-11 | DSB | 29-Jun-11 30-Jun-11 | **002** | Reliability | DTO data report for March 2011. |
| DSB | | DTO MG Monitoring of MPTO1 and NT+4 Trainsets for March 2011 | hard pdf | | 11-Apr-11 | DSB | 29-Jun-11 30-Jun-11 | **003** | Reliability | DTO data monitoring for March 2011. |
| DSB | | DTO Conclusions April 2011 | hard pdf | | 18-May-11 | DSB | 29-Jun-11 30-Jun-11 | **004** | Reliability | DTO data report for April 2011. |
| DSB | | IC4 Program Organisationsdiagram | hard pdf | | 29-Jun-11 | DSB | 29-Jun-11 | **005** | Organisational | Organisation chart for IC4 Project Team |
| DSB | | Information om IC4 | hard | | Dec-10 | DSB | 29-Jun-11 | **006** | Information | DSB Publicity leaflet. |
| DSB | AQU IO/045 | IC4 Authority Approval Process - Documentation Delivery Status | hard pdf | 22/AE | 07-Oct-10 | DSB | 29-Jun-11 | **007** | Approval | Status of delivery documentation for approval up to MPTO Pack 1. |
| DSB | P000170011 | Safety Plan for IC4 and NT Fleet (MTTA and STTA operation) (Sikkerhedsplan For IC4- og NT-fladen (MTTA og STTA driftsformen)) | hard pdf | 04 | 09-Sep-10 | DSB | 29-Jun-11 | **008** | Approval | Safety Plan for project safety management. |
| DSB | | IC4 Programmets organisering | hard pdf | | 01-Apr-11 | DSB | 30-Jun-11 | **009** | Organisational | Organisation chart for IC4 Project Team up to 01 Apr 11. |
| DSB | | Quality Management System | hard pdf | | | DSB | 30-Jun-11 | **010** | Quality | Presentation on IC4 quality (5 slides). |
| DSB | | Activity Description (Aktivitetsbeskrivelses) | hard pdf | | 21-Jun-11 | DSB | 30-Jun-11 | **011** | Quality | Flow chart for hardware CFG process management (page 79 of 160) from Quality Procedure. |
| DSB | P000160618 | Passenger Information System (PIS) Diagram (page 31 in OIS SFDD) | hard jpg | | | DSB | 30-Jun-11 | **012** | Technical | PIS architecture diagram. |
| DSB | STP 158 AA07CA5 | Technical Production Specification - TRAIN Configuration Updating PRODUCTION PROCESS and DEFINITION OF CONTROL/TESTING PHASES | pdf | 06 | 22-Oct-10 | AB | 30-Jun-11 | **013** | Production | Production specification for AB production processes in Italy and Denmark up to DSB Takeover. |
| DSB | | IC4 Implementering af Pakke 2 på MPTO togsæt | mpp | 07 | 01-Jul-11 | DSB | 30-Jun-11 | **014** | Production | Pack 2 implementation programme (updated by URN 036). |
| DSB | AA056WX | Design Configuration Document | pdf | 22 | 17-May-07 | AB | 30-Jun-11 | **015** | Technical | Defines the train design configuration at Pack5, 6, and 7, with 1,495 CFGs. |
| DSB | | IC4 Baggrund | pdf | | | DSB | 30-Jun-11 | **016** | Information | Page from DSB website. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | Dieseltogsæt, IC4, fjerntog | pdf | | | DSB | 30-Jun-11 | **017** | Information | Page from DSB website. |
| DSB | AA01K7H | Interior Equipments Layout (3 sheets) | pdf | 03 | 18-Dec-03 | AB | 30-Jun-11 | **018** | Technical | Vehicle general arrangement drawings. |
| DSB | AA07186 | Design Configuration Document and Train Version Identification for National Traffic Mission Profile | pdf | 09 | 30-Sep-08 | AB | 30-Jun-11 | **019** | Technical | Defines the train design configuration for NT. |
| DSB | AA07189 | Design Configuration Document and Train Version Identification for Multiple Train Profile | pdf | 09 | 13-Mar-09 | AB | 30-Jun-11 | **020** | Technical | Defines the train design configuration for Multiple Train Profile. |
| DSB | P000174022 | Design Configuration Document for MPTO Pack 1 | pdf | 04 | 01-Apr-11 | DSB | 30-Jun-11 | **021** | Technical | Defines the train design configuration for MPTO Pack 1. |
| DSB | Appendix 1.6 | MPTO Train Master Plan | pdf | | 15-May-09 | AB | 30-Jun-11 | **022** | Contractual | Master Plan for delivery of Train Units 21, 22, 23, and the MPTO Train Units under the Addendum. |
| DSB | | Known Issues List | pdf | 5 | 08-Apr-10 | DSB | 30-Jun-11 | **023** | Production | Table of 50 Known Issues derived from 750 technical issues from NT train operation. |
| DSB | | Produktions - og indsættelsesplan for MPTO togsæt til passagertraffik | xls | 51 | | DSB | 30-Jun-11 | **024** | Production | MPTO production plan for IC4 from week 43/10 to 39/12 and IC2 from week 26/11 to 48/12. |
| DSB | P000217543 | Train History Book - Train set # 48 | pdf | 1 | 05-May-11 | AB | 30-Jun-11 | **025** | Production | Record of the Final Assembly (rev 0) and Commissioning (rev 1) for Train set no. 48 in 15 sections. |
| DSB | | AnsaldoBreda Due Diligence - Supply Chain Risk Assessment for IC4 / IC2 | pdf | | Mar-11 | Deloitte | 30-Jun-11 | **026** | Production | Due diligence review by Deloitte of IC4/IC2 scheduled deliveries. Identifies supply risks and recommends an action plan. |
| DSB | | Addresser | doc | 1 | 30-Jun-11 | DSB | 30-Jun-11 | **027** | Organisational | DSB IC4 project team contact details. |
| DSB | | TOKR trekant | ppt | | | DSB | 30-Jun-11 | **028** | Contractual | Diagrammatic representation of IC4 project. |
| DSB | | DTO Conclusions May 2011 | pdf | | 15-Jun-11 | DSB | 30-Jun-11 | **029** | Reliability | DTO data report for May 2011. |
| DSB | | Addresser | doc | 2 | 30-Jun-11 | DSB | 30-Jun-11 | **030** | Organisational | DSB IC4 project team contact details. |
| DSB | | Opstartsmode 29062011 | doc | | 29-Jun-11 | DSB | 30-Jun-11 | **031** | Information | Notes of start-up meeting between Atkins and DSB. |
| DSB | | DTO Monthly Meeting IC4 May 2011 | doc | | 09-Jun-11 | DSB | 30-Jun-11 | **032** | Reliability | Notes of DTO Monthly Meeting - May 2011. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | DTO Monthly Meeting IC4 April 2011 | doc | | 14-May-11 | DSB | 30-Jun-11 | **033** | Reliability | Notes of DTO Monthly Meeting - April 2011. |
| DSB | | DTO MG Monitoring of MPTO1 and NT+4 Trainsets for April 2011 | pdf | | 09-May-11 | DSB | 30-Jun-11 | **034** | Reliability | DTO data monitoring for April 2011 |
| DSB | | DTO MG Monitoring of MPTO1 and NT+4 Trainsets for May 2011 | pdf | | 07-Jun-11 | DSB | 30-Jun-11 | **035** | Reliability | DTO data monitoring for May 2011 |
| DSB | | IC4 Implementering af Pakke 2 på MPTO togsæt | mpp | 07 | 02-Jul-11 | DSB | 30-Jun-11 | **036** | Production | Pack 2 implementation programme (updated from URN 014). |
| DSB | AA01KUC | Architecture Train Communication Network | pdf | 05 | 20-Jan-10 | AB | 01-Jul-11 | **037** | Technical | TCMS diagram covering the 4-car unit. |
| DSB | | Appendix 1 to Amendment to Addendum to IC4 Addendum Second Revised Appendix 1.6 (Delivery Master Plan) | pdf | | | DSB | 01-Jul-11 | **038** | Contractual | Amendment to URN 022 MPTO Train Master Plan. |
| DSB | XHESA0101 | 16. Styring af dokumenter, kvalitetsregistreringer og data | pdf | 1.9 | 20-Jun-11 | DSB | 01-Jul-11 | **039** | Quality | Quality procedure for registering documents. |
| DSB | | AB's Reply to Deloitte's Supply Chain Risk Assessment for IC4/IC2 projects | pdf | | 21-Jun-11 | AB | 04-Jul-11 | **040** | Production | AB's response to Deloitte's supply chain risk assessment for IC4/IC2 projects. |
| TS | GML/GNR/0708654 | IC4 Project AAPP - AUTHORITY APPROVAL PROCESS PLAN | hard pdf | 12 | 23-Jan-09 | AB | 05-Jul-11 | **041** | Approval | AB's authority approval process plan. |
| TS | Journal T541-000765 Dok. Nr. 1070107 | Betinget Typegodkendelse MPTO P1 (Litra MG) | hard pdf | | 04-Nov-10 | TS | 05-Jul-11 | **042** | Approval | Type approval document for MPTO Pack 1 train configuration. |
| TS | Journal T541-000765 Dok. Nr. 1075556 | Betinget Typegodkendelse NT Pakke 1 (Litra MG) | hard pdf | | 24-Nov-10 | TS | 05-Jul-11 | **043** | Approval | Type approval document for NT Pack 1 train configuration. |
| TS | Rb001.430 | IC4 Project - Submittal of the AnsaldoBreda document no. SQU 461 Rev.1 "Procedure for managing the Authority Approval Process" | pdf | | 28-May-02 | AB | 05-Jul-11 | **044** | Approval | AB procedure for managing the approval process. |
| TS | SQU/461 | IC4 DMU - SQU 461 - Managing the Authority Approval Process | pdf | 1 | 24-Apr-02 | AB | 05-Jul-11 | **045** | Approval | AB procedure for managing the approval process. |
| TS | | E-mail from Leif Funch (TS) to Saulle Aldo (AB) with TS's acceptance of new appendix to SQU 461 | doc | | 07-Dec-07 | TS | 05-Jul-11 | **046** | Approval | TS communication to AB. |
| TS | Journal T541-000430 Dok. Nr. 000430 | Letter from Leif Funch (TS) to Also Saulle (AB) "Acceptance of new appendix to9 SQU 461" | pdf | | 07-Dec-07 | TS | 05-Jul-11 | **047** | Approval | TS communication to AB. |
| TS | GML/GNR/0708654 | IC4 Project AAPP - AUTHORITY APPROVAL PROCESS PLAN | doc | 9 | 04-Dec-07 | AB | 05-Jul-11 | **048** | Approval | AB procedure for managing the approval process. |

| Source | Document Ref. | Document Title | Format | Rev | Date | By | Date Received | URN | Category | Document Content |
|---|---|---|---|---|---|---|---|---|---|---|
| TS | Journal T541-000765<br>Dok. Nr. 000765 | IC4 - Conditional Type Approval (NT+ configuration) | doc | | 27-Jan-09 | TS | 05-Jul-11 | **049** | Approval | NT+ conditional type approval from TS. |
| TS | Journal T541-000765<br>Dok. Nr. 843023 | Addendum to conditional Type approval of DMU IC4, C-MTTA | pdf | | 07-May-09 | TS | 05-Jul-11 | **050** | Approval | Addendum to conditional Type approval for C-MTTA (URN 102 in English). |
| TS | Journal T541-000765<br>Dok. Nr. 843022 | Conditional Type approval of DMU IC4, C-MTTA | pdf | | 07-May-09 | TS | 05-Jul-11 | **051** | Approval | Conditional Type approval for C-MTTA (URN 101 in English). |
| TS | Journal T541-000765<br>Dok. Nr. 1041588 | Typegodkendelse for IC4 (NT+ konfiguration) | doc | | 09-Jul-10 | TS | 05-Jul-11 | **052** | Approval | NT+ type approval from TS. |
| DSB | COC 5607 101112<br>P000172771<br>Rb 001.003 | Certificate of Conformity CoC 5607 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **053** | Contractual | Certificate of conformance for trainset 5607. |
| DSB | COC 5608 101112<br>P000172777<br>Rb 001.003 | Certificate of Conformity CoC 5608 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **054** | Contractual | Certificate of conformance for trainset 5608. |
| DSB | COC 5611 101112<br>P000172778<br>Rb 001.003 | Certificate of Conformity CoC 5611 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **055** | Contractual | Certificate of conformance for trainset 5611. |
| DSB | COC 5612 101112<br>P000172802<br>Rb 001.003 | Certificate of Conformity CoC 5612 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **056** | Contractual | Certificate of conformance for trainset 5612. |
| DSB | COC 5613 101112<br>P000172787<br>Rb 001.003 | Certificate of Conformity CoC 5613 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **057** | Contractual | Certificate of conformance for trainset 5613. |
| DSB | COC 5614 101112<br>P000172535<br>Rb 001.003 | Certificate of Conformity CoC 5614 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **058** | Contractual | Certificate of conformance for trainset 5614. |
| DSB | COC 5615 101112<br>P000172796<br>Rb 001.003 | Certificate of Conformity CoC 5615 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **059** | Contractual | Certificate of conformance for trainset 5615. |
| DSB | COC 5616 101112<br>P000172812<br>Rb 001.003 | Certificate of Conformity CoC 5616 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **060** | Contractual | Certificate of conformance for trainset 5615. |
| DSB | COC 5617 101112<br>P000171066<br>Rb 001.003 | Certificate of Conformity CoC 5617 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **061** | Contractual | Certificate of conformance for trainset 5615. |
| DSB | COC 5618 101112<br>P000176249<br>Rb 001.003 | Certificate of Conformity CoC 5618 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **062** | Contractual | Certificate of conformance for trainset 5615. |
| DSB | COC 5619 101112<br>P000172505<br>Rb 001.003 | Certificate of Conformity CoC 5619 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **063** | Contractual | Certificate of conformance for trainset 5615. |
| DSB | COC 5620 101112<br>P000172798<br>Rb 001.003 | Certificate of Conformity CoC 5620 101112 | pdf | | 12-Nov-10 | DSB | 05-Jul-11 | **064** | Contractual | Certificate of conformance for trainset 5615. |

| Source | Document Ref. | Document Title | Format | Rev | Date | By | Date Received | URN | Category | Document Content |
|---|---|---|---|---|---|---|---|---|---|---|
| DSB | COC 5627 101130<br>P000172798<br>Rb 001.003 | Togsaet 27's Overensstemmelseserklaering for 'MPTO pakke 1' CoC 5627 101130 | pdf | | 30-Nov-10 | DSB | 05-Jul-11 | **065** | Contractual | DSB Declaration of Conformity with 'MPTO Pack 1' for trainset 27. |
| DSB | AQU/TR27-10-11-29 | Trainset # 27, litre MG 5627 | pdf | | 29-Nov-10 | AB | 05-Jul-11 | **066** | Contractual | AB Aarhus site Declaration of Conformity with C-MTTA for Trainset 27. |
| DSB | AQU/TR30-10-05-31<br>P000180837 | Trainset # 30 litre MG 5630 | pdf | | 31-May-10 | AB | 05-Jul-11 | **067** | Contractual | AB Aarhus site Declaration of Conformity for Trainset 27 (Restricted Test Running). |
| DSB | AQU/TR43-11-03-25<br>P000216362 | Trainset # 43 litre MG 5643 | pdf | | 25-Mar-11 | AB | 05-Jul-11 | **068** | Contractual | AB Aarhus site Declaration of Conformity with C-MTTA for Trainset 43. |
| DSB | IC4-4637<br>CoC AQU/TR37-11-04-29 | DSB IC4 DMU CoC Acknowledgement For Train set # 37 Mission Profile: RTR | pdf | E | 02-May-11 | DSB | 05-Jul-11 | **069** | Contractual | DSB acknowledgement of CoC for trainset 37. |
| DSB | IC4-4637<br>CoC AQU/TR40-11-01-14 | DSB IC4 DMU CoC Acknowledgement For Train set # 40 Mission Profile: RTR | pdf | E | 02-Feb-11 | DSB | 05-Jul-11 | **070** | Contractual | DSB acknowledgement of CoC for trainset 40. |
| DSB | IC4-4637<br>CoC AQU/TR41-11-01-24 | DSB IC4 DMU CoC Acknowledgement For Train set # 41 Mission Profile: RTR | pdf | E | 03-Feb-11 | DSB | 05-Jul-11 | **071** | Contractual | DSB acknowledgement of CoC for trainset 41. |
| DSB | IC4-4637<br>CoC AQU/TR43-10-12-30 | DSB IC4 DMU CoC Acknowledgement For Train set # 43 Mission Profile: RTR | pdf | E | 01-Feb-11 | DSB | 05-Jul-11 | **072** | Contractual | DSB acknowledgement of CoC for trainset 43. |
| DSB | IC4-4637<br>CoC AQU/TR44-11-02-09a | DSB IC4 DMU CoC Acknowledgement For Train set # 44 Mission Profile: RTR | pdf | E | 11-Feb-11 | DSB | 05-Jul-11 | **073** | Contractual | DSB acknowledgement of CoC for trainset 44. |
| DSB | COC 5629 291108<br>Rb 001.003 | Togsaet 29's Overensstemmelseserklaering for 'MPTO pakke 1' RTR. CoC 5629 291108 | pdf | | 29-Nov-10 | DSB | 05-Jul-11 | **074** | Contractual | DSB Declaration of Conformity for Restricted Test Running for Trainset 29. |
| DSB | COC 5639 110207<br>Rb 001.003<br>P000214606 | Togsaet 39's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5639 110207 | pdf | | 07-Feb-11 | DSB | 05-Jul-11 | **075** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 39. |
| DSB | COC 5643 110405<br>Rb 001.003<br>P000216588 | Togsaet 43's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5643 110405 | pdf | | 05-Apr-11 | DSB | 05-Jul-11 | **076** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 43. |
| DSB | IC4-4637<br>CoC AQU/TR42-11-02-22 | DSB IC4 DMU CoC Acknowledgement For Train set # 42 Mission Profile: RTR | pdf | E | 22-Feb-11 | DSB | 05-Jul-11 | **077** | Contractual | DSB acknowledgment of RTR for trainset 42. |
| DSB | IC4-4637<br>CoC AQU/TR47-11-03-22 | DSB IC4 DMU CoC Acknowledgement For Train set # 47 Mission Profile: RTR | pdf | E | 22-Mar-11 | DSB | 05-Jul-11 | **078** | Contractual | DSB acknowledgment of RTR for trainset 47. |
| DSB | IC4-4637<br>CoC AQU/TR49-11-05-27 | DSB IC4 DMU CoC Acknowledgement For Train set # 49 Mission Profile: RTR | pdf | E | 30-May-11 | DSB | 05-Jul-11 | **079** | Contractual | DSB acknowledgment of RTR for trainset 49. |
| DSB | IC4-4637<br>CoC AQU/TR51-11-05-16 | DSB IC4 DMU CoC Acknowledgement For Train set # 51 Mission Profile: RTR | pdf | E | 17-May-11 | DSB | 05-Jul-11 | **080** | Contractual | DSB acknowledgment of RTR for trainset 51. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | IC4-4637<br>CoC AQU/TR34-11-03-15 | DSB IC4 DMU CoC Acknowledgement For Train set # 34 Mission Profile: RTR | pdf | E | 15-Mar-11 | DSB | 05-Jul-11 | **081** | Contractual | DSB acknowledgment of RTR for trainset 34. |
| DSB | IC4-4637<br>CoC AQU/TR46-11-04-12 | DSB IC4 DMU CoC Acknowledgement For Train set # 46 Mission Profile: RTR | pdf | E | 12-Apr-11 | DSB | 05-Jul-11 | **082** | Contractual | DSB acknowledgment of RTR for trainset 46. |
| DSB | IC4-4637<br>CoC AQU/TR60-11-06-23 | DSB IC4 DMU CoC Acknowledgement For Train set # 60 Mission Profile: RTR | pdf | E | 23-Jun-11 | DSB | 05-Jul-11 | **083** | Contractual | DSB acknowledgment of RTR for trainset 60. |
| DSB | COC 5635 110104<br>Rb 001.003 | Togsaet 35's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5635 110104 | pdf | | 04-Jan-11 | DSB | 05-Jul-11 | **084** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 35. |
| DSB | AQU/TR25-11-05-19 | Trainset # 25 litre MG 5625 | pdf | | 19-May-11 | AB | 05-Jul-11 | **085** | Contractual | AB Aarhus Declaration of Conformity for TCMS Pack 2 Restricted Test Running for Trainset 25. |
| DSB | AQU/TR26-11-05-19 | Trainset # 26 litre MG 5626 | pdf | | 19-May-11 | AB | 05-Jul-11 | **086** | Contractual | AB Aarhus Declaration of Conformity for TCMS Pack 2 Restricted Test Running for Trainset 26. |
| DSB | AQU/TR28-11-05-19 | Trainset # 28 litre MG 5628 | pdf | | 19-May-11 | AB | 05-Jul-11 | **087** | Contractual | AB Aarhus Declaration of Conformity for TCMS Pack 2 Restricted Test Running for Trainset 28. |
| DSB | AQU/TR23-10-01-29 | Trainset # 23 litre MG 5623 | pdf | | 29-Jan-10 | AB | 05-Jul-11 | **088** | Contractual | AB Aarhus Declaration of Conformity for C-MTTA for Trainset 26. |
| DSB | COC 5618 110311<br>Rb 001.003<br>P000176249 | Togsaet 18's Overensstemmelseserklaering for 'NT' C-STTA. CoC 5618 110311 | pdf | | 11-Mar-11 | DSB | 05-Jul-11 | **089** | Contractual | DSB Declaration of Conformity with NT C-STTA for Trainset 18. |
| DSB | COC 5624 101214<br>Rb 001.003 | Togsaet 24's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5624 101214 | pdf | | 14-Dec-10 | DSB | 05-Jul-11 | **090** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 24. |
| DSB | COC 5629 101216<br>Rb 001.003 | Togsaet 29's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5629 101216 | pdf | | 16-Dec-10 | DSB | 05-Jul-11 | **091** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 29. |
| DSB | COC 5632 101216<br>Rb 001.003 | Togsaet 32's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5632 101216 | pdf | | 16-Dec-10 | DSB | 05-Jul-11 | **092** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 32. |
| DSB | COC 5640 110511<br>Rb 001.003 | Togsaet 40's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5640 110511 | pdf | | 11-May-11 | DSB | 05-Jul-11 | **093** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 40. |
| DSB | COC 5641 110511<br>Rb 001.003 | Togsaet 41's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5641 110511 | pdf | | 11-May-11 | DSB | 05-Jul-11 | **094** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 41. |
| DSB | COC 5642 110608<br>Rb 001.003 | Togsaet 42's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5642 110608 | pdf | | 08-Jun-11 | DSB | 05-Jul-11 | **095** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 42. |
| DSB | COC 5644 110511<br>Rb 001.003 | Togsaet 44's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5644 110511 | pdf | | 11-May-11 | DSB | 05-Jul-11 | **096** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 44. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | COC 5645 110531<br>Rb 001.003<br>P000218175 | Togsaet 45's Overensstemmelseserklaering for 'MPTO pakke 1' C-MTTA. CoC 5645 110531 | pdf | | 31-May-11 | DSB | 05-Jul-11 | **097** | Contractual | DSB Declaration of Conformity with MPTO Pack 1 C-MTTA for Trainset 45. |
| DSB | AQU/TR24-10-12-14 | Trainset # 24 litre MG 5624 | pdf | | 14-Dec-10 | AB | 05-Jul-11 | **098** | Contractual | AB Aarhus Declaration of Conformity for C-MTTA for Trainset 24. |
| DSB | AQU/TR29-10-12-16 | Trainset # 29 litre MG 5629 | pdf | | 16-Dec-10 | AB | 05-Jul-11 | **099** | Contractual | AB Aarhus Declaration of Conformity for C-MTTA for Trainset 29. |
| DSB | AQU/TR32-10-12-15 | Trainset # 32 litre MG 5632 | pdf | | 15-Dec-10 | AB | 05-Jul-11 | **100** | Contractual | AB Aarhus Declaration of Conformity for C-MTTA for Trainset 32. |
| DSB | Journal T541-000765<br>Dok. Nr. 841563 | Betinget Typegodkendelse af DMY IC4, C-MTTA | pdf | | 04-May-09 | TS | 05-Jul-11 | **101** | Approval | URN 051 in Danish. |
| DSB | Journal T541-000765<br>Dok. Nr. 841562 | Bilag til betinget Typegodkendelse af DMY IC4, C-MTTA | pdf | | 04-May-09 | TS | 05-Jul-11 | **102** | Approval | URN 050 in Danish. |
| DSB | BCF-IC4-4570<br>P000161522 | Letter from Roberto Pecchioli (AB) to Ole H Hertel (DSB) "AB Recovery Plan to meet May 1st, 2009 goal" | pdf | | 04-Mar-09 | AB | 05-Jul-11 | **103** | Contractual | AB communication to DSB |
| DSB | AA07186<br>P000164208 | Design Configuration Document and Train Version Identification for National Traffic Mission Profile | doc | 11<br>Draft 3 | 11-May-09 | AB | 05-Jul-11 | **104** | Technical | Design configuration document for NT trainsets. |
| DSB | P000183021 | Time Tracking Report - IC4 Delivery | xls | | 09-Aug-10 | DSB | 05-Jul-11 | **105** | Production | Record of AB deliveries. |
| DSB | | OUT og IC4 - Kilometer mellem haendelser | pdf | | | DSB | 05-Jul-11 | **106** | Reliability | Graph showing predicted reliability of IC4 in comparison with OTU. |
| DSB | | Overordnet udviklingsforlob | ppt | | | DSB | 05-Jul-11 | **107** | Production | Slide showing development of train configuration from NT+ to 'Pack 3'. |
| DSB | P000214354 | Train History Book - Train set # 24 | pdf | 1 | 30-Nov-10 | AB | 05-Jul-11 | **108** | Contractual | Record of train production at Takeover by DSB from AB for trainset 24. |
| DSB | P000213490 | Train History Book - Train set # 27 | pdf | 1 | 02-Dec-10 | AB | 05-Jul-11 | **109** | Contractual | Record of train production at Takeover by DSB from AB for trainset 27. |
| DSB | P000214723 | Train History Book - Train set # 29 | pdf | 1 | 29-Dec-10 | AB | 05-Jul-11 | **110** | Contractual | Record of train production at Takeover by DSB from AB for trainset 29. |
| DSB | | ODI MG version 7 - Gaeldende fra 29-05-2011 | pdf | | 29-May-11 | DSB | 05-Jul-11 | **111** | Operational | Operating Drivers Instructions. |
| DSB | | ODI MG version 7 - Gaeldende fra 29-05-2011 | pdf | | 29-May-11 | DSB | 05-Jul-11 | **112** | Operational | Operating Drivers Instructions. Appears to be the same as URN 111, but with additional sections and 50 extra pages. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | SAF - AA084Z0 P000172448 | Summary of Safety Analyses results for Safety Critical Sub Systems | pdf | 2 | 12-Nov-09 | AB | 05-Jul-11 | **113** | Safety | AB summary of safety analyses. |
| DSB | RAM - AA022H1 P000089994 | Preliminary Hazard Identification and Analysis (PHIA) | pdf | 2 | 20-Jan-03 | AB | 05-Jul-11 | **114** | Safety | AB document of hazard identification and analysis. |
| DSB | STE RAM AA046N9 P000169245 | Preventive Maintenance Programme | pdf | 10 | 30-Oct-08 | AB | 05-Jul-11 | **115** | Maintenance | AB schedule for preventive maintenance. |
| DSB | STE RAM AA02ZKM P000210376 | RCM Analysis and Maintenance Program | pdf | 6 | 09-Nov-07 | AB | 05-Jul-11 | **116** | Reliability | AB document of RCM analysis and maintenance program. |
| DSB | AA02RXH P000210240 | DSB - IC4 Programmet - Annex 12 Hazard Log | doc | 10/AE | 06-Oct-10 | DSB | 05-Jul-11 | **117** | Safety | DSB hazard log. |
| DSB | P000182657 | DSB - IC4 Programmet - Annex 17 Hazard/subsystem cross reference matrix | doc | 00 | 26-Jul-10 | DSB | 05-Jul-11 | **118** | Safety | DSB cross-references between the hazard log and subsystems. |
| DSB | P000182692 | DSB - IC4 Programmet - Annex 19 Operational experiences | doc | 02 | 07-Oct-10 | DSB | 05-Jul-11 | **119** | Safety | Annex to DSB's Safety Case setting out operational experiences from before Jul 07 to Oct 10. |
| DSB | P000210240 | DSB - IC4 Programmet - Annex 20 CFG changes in "MPTO pakke 1" | doc | 01 | 06-Oct-10 | DSB | 05-Jul-11 | **120** | Safety | Annex to DSB's Safety Case setting out CFGs for Pack 1 fitment. |
| DSB | AA03Y1X P000158094 | Cab HVAC - Heating, Ventilation and Air Condition for Drivers Cabin (SFDD HVAC) | doc | 6 | 21-Oct-08 | AB | 05-Jul-11 | **121** | Technical | SFDD for cab HVAC. |
| DSB | AA03Y1R Rb 001.530 P000158092 | SFDD HVAC Passenger | doc | 06/AA | 10-Aug-10 | AB | 05-Jul-11 | **122** | Technical | SFDD for saloon HVAC. |
| DSB | AA040JP P000158214 | Miscellaneous Equipment (SFDD) | doc | 6 | 03-Nov-08 | AB | 05-Jul-11 | **123** | Technical | SFDD for miscellaneous equipment including inter alia windscreens, wash/wipe, trolley lift, flange lubrication, door video surveillance. |
| DSB | AA03Y1Z P000159876 | Power Management (SFDD) | doc | 7 | 18-Nov-08 | AB | 05-Jul-11 | **124** | Technical | SFDD for power management. |
| DSB | | IC4 DV organisation til Atkins 7.7.11 | ppt | | 07-Jul-11 | DSB | 07-Jul-11 | **125** | Organisational | Drift team organogram with manpower. |
| DSB | | Brev ang rettidighedssituationen | pdf | final | | DSB | 07-Jul-11 | **126** | Information | Letter (in Danish) regarding punctuality. |
| DSB | | IC4 rapportering 2011 - IC4 opfolgning, juni 2011 | xls | | 30-Jun-11 | DSB | 07-Jul-11 | **127** | Operational | IC4 Operations report, June 2011 showing day by day status of each unit and traffic incidents/delays. |
| DSB | | IC4 Status 06/07/11 - NT++ and MPTO | xls | | 06-Jul-11 | DSB | 08-Jul-11 | **128** | Operational | Status of trainsets in traffic or simulation as at 06 Jul 11. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | Stock-flow-diagram 2011-07-07 | xls | | 07-Jul-11 | DSB | 08-Jul-11 | **129** | Production | Status of IC4 cars and trainsets at AB in Italy as at 07 Jul 11. |
| DSB | AA01HCC | Rules for the Working Out of Electric Diagrams, Wiring and Cable Marking | pdf | 0 | 21-Mar-01 | AB | 08-Jul-11 | **130** | Technical | Not required. |
| DSB | PMT - AA01HCJ | Technical Specification for Heating, Ventilation and Air Conditioning System | pdf | 0 | 13-Feb-01 | AB | 08-Jul-11 | **131** | Technical | Technical specification for HVAC system. |
| DSB | PFE/AA01HCK | Technical Specification for External Doors | pdf | 1 | 02-Feb-01 | AB | 08-Jul-11 | **132** | Technical | Technical specification for external doors |
| DSB | AA01JCL | Driver's Cab Layout (sheet 1 of 3) | pdf | 15 | 23-Nov-09 | AB | 08-Jul-11 | **133** | Technical | Drawing of Driver's cab layout (sheet 1 of 3) |
| DSB | AA01JCL | Driver's Cab Layout (sheet 2 of 3) | pdf | 15 | 23-Nov-09 | AB | 08-Jul-11 | **134** | Technical | Drawing of Driver's cab layout (sheet 2 of 3) |
| DSB | AA01JCL | Driver's Cab Layout (sheet 3 of 3) | pdf | 15 | 23-Nov-09 | AB | 08-Jul-11 | **135** | Technical | Drawing of Driver's cab layout (sheet 3 of 3) |
| DSB | PVE AA04ZRL | DSAT 22/3 - Vehicle Test Type Procedure - Multiple operation of train units | pdf | 4 | 12-Feb-09 | AB | 08-Jul-11 | **136** | Technical | Type test procedure for multiple operation. |
| DSB | PVE - AA05V1E | DFAT 23/1 - IDU System | pdf | 1 | 22-Feb-08 | AB | 08-Jul-11 | **137** | Technical | Design factory acceptance test procedure for IDU. |
| DSB | PVE - AA05VD1 | DFAT 23/1 - IDU System | pdf | 6 | 09-Jan-08 | AB | 08-Jul-11 | **138** | Technical | Design factory acceptance test procedure for IDU. |
| DSB | UTQ - AA020LU | DFAT 23 - Train Computer Test | pdf | 6 | 20-Feb-06 | AB | 08-Jul-11 | **139** | Technical | Design factory acceptance test procedure for train computers. |
| DSB | PVE AA0846U | DSAT 22/3 - Test Report - Multiple operation of train units - Train Number: 9 and 10 | pdf | 0 | | AB | 08-Jul-11 | **140** | Technical | Type test report for multiple operation with trainsets 09 and 10. |
| DSB | | Estimeret IC4 peformance ift. Respektive planlagte opgraderingspakker | doc | | 29-May-11 | DSB | 08-Jul-11 | **141** | Reliability | Estimated IC4 reliability performance relative to respective planned upgrade packages. |
| DSB | | Estimeret IC4 peformance ift. Respektive planlagte opgraderingspakker | doc | | 29-May-11 | DSB | 08-Jul-11 | **141E** | Reliability | English translation of URN 141. |
| DSB | | IC4 Sap maj month | xls | | | DSB | 08-Jul-11 | **142** | Maintenance | Inspection and repair reports in SAP in May 11. |
| DSB | | DCDK & IC4 Support | pdf | 00 | 16-Jun-11 | DSB | 08-Jul-11 | **143** | Operational | Flow chart for reporting and following up an incident in traffic. |
| DSB | | DTO for maj month | csv | | | DSB | 08-Jul-11 | **144** | Operational | DTO records for May 11. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | Præsentation af ændringer i 2 enheder i F&R | pdf | | | DSB | 11-Jul-11 | **145** | Organisational | Organisation chart showing changes in IC4 part of DSB Fjern- & Regionaltog organisation. |
| DSB | | IC4 PMP/NT++ 75.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **146** | Maintenance | Extract from 75,000 km overhaul instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 135.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **147** | Maintenance | Extract from 135,000 km overhaul instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 150.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **148** | Maintenance | Extract from 150,000 km overhaul instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 165.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **149** | Maintenance | Extract from 165,000 km overhaul instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 5.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **150** | Maintenance | Extract from 5,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 15.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **151** | Maintenance | Extract from 15,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 30.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **152** | Maintenance | Extract from 30,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 45.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **153** | Maintenance | Extract from 45,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 60.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **154** | Maintenance | Extract from 60,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 90.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **155** | Maintenance | Extract from 90,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 105.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **156** | Maintenance | Extract from 105,000 km exam instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 120.000 Km eftersyn på Dansk | xls | | | DSB | 11-Jul-11 | **157** | Maintenance | Extract from 120,000 km exam instruction for NT++ trainsets. |
| DSB | | Rensning af vandtanke | xls | | | DSB | 11-Jul-11 | **158** | Maintenance | Instruction for internal cleaning of water tanks. |
| DSB | | IC4 PMP/NT++ 195.000 Km eftersyn på Dansk | pdf | | | DSB | 11-Jul-11 | **159** | Maintenance | Extract from 195,000 km overhaul instruction for NT++ trainsets. |
| DSB | | IC4 PMP/NT++ 210.000 Km eftersyn på Dansk | pdf | | | DSB | 11-Jul-11 | **160** | Maintenance | Extract from 210,000 km overhaul instruction for NT++ trainsets. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | IC4 PMP/NT++ 225.000 Km eftersyn på Dansk | pdf | | | DSB | 11-Jul-11 | **161** | Maintenance | Extract from 225,000 km overhaul instruction for NT++ trainsets. |
| DSB | | E-mail from Eluf Nielsen (DSB) to Hans Jacob Sorup Jacobsen "Eftersyns dokumentation 21-06-2011" | zip | | 21-Jun-11 | DSB | 11-Jul-11 | **162** | Maintenance | Detailed set of maintenance and inspection documents in a zip file. |
| DSB | MG 5644 | Indsyn og udsyn - IC4 Togsæt | hard | 1 | 29-Mar-11 | DSB | 06-Jul-11 | **163** | Production | List of open issues for train set 44. |
| DSB | CFG-DSB Nr. 0065<br>Rb 001.305 | Aflastningsventil | hard | | 21-Jun-10 | DSB | 06-Jul-11 | **164** | Production | Document trail for an example CFG - Identification and description. |
| DSB | CFG-DSB Nummer. 0065<br>Rb 001.305 | Kravspecifikation | hard | 1.0 | 22-Jun-10 | DSB | 06-Jul-11 | **165** | Production | Document trail for an example CFG - Specification. |
| DSB | P000177177<br>CFG no. 0065<br>Rb 001.703 | Referat af Hazard workshop | hard | 01 | 22-Apr-10 | DSB | 06-Jul-11 | **166** | Production | Document trail for an example CFG - Hazard workshop summary. |
| DSB | | Provekorselsstilladelse | hard | | 30-Jul-10 | DSB | 06-Jul-11 | **167-1** | Production | Document trail for an example CFG - Initial safety assessment. |
| DSB | | Risikoanalyse for evt. Provekorsel | hard | | 29-Jul-10 | DSB | 06-Jul-11 | **167-2** | Production | Document trail for an example CFG - Risk assessment by validator. |
| DSB | | Testkorsel med udledning af aflastningsluft gennem filtre | hard | | | DSB | 06-Jul-11 | **168** | Production | Document trail for an example CFG - Application for testing. |
| DSB | CFG DSB nummer: 0065<br>Rb 001.305 | Kravspecifikation | hard | 1.0 | 25-Oct-10 | DSB | 06-Jul-11 | **169** | Production | Document trail for an example CFG - Test report. |
| DSB | CFG DSB nummer: 0065<br>Rb 001.306 | Verifikationsrapport | hard | | 28-Oct-10 | DSB | 06-Jul-11 | **170** | Production | Document trail for an example CFG - Verification report. |
| DSB | P000212590 | Arbejdsinstruktion | hard | 1 | 17-Nov-10 | DSB | 06-Jul-11 | **171** | Production | Document trail for an example CFG - Modification instruction. |
| DSB | P000213912 | Operator selvkontrol | hard | 0 | 22-Nov-10 | DSB | 06-Jul-11 | **172** | Production | Document trail for an example CFG - Certification of completion. |
| DSB | P000212590 | Working instruction | hard | 1 | 23-Feb-11 | DSB | 06-Jul-11 | **173** | Production | Document trail for an example CFG - Working instruction for feedback to Italy. |
| DSB | CFG DSB nummer: 0065<br>Rb 001.305 | Konstruktionsgransknings rapport | hard | | 28-Jan-11 | DSB | 06-Jul-11 | **174** | Production | Document trail for an example CFG - post-completion report. |
| DSB | P000180964<br>Rb 001.003 | Sikkerhedsbevis | hard | 00 | 18-Nov-10 | DSB | 06-Jul-11 | **175** | Production | Document trail for an example CFG - Hazard close-out by validator. |
| DSB | CFG DSB nummer: 0065<br>Rb 001.303 | Valideringsrapport | hard | | | DSB | 06-Jul-11 | **176** | Production | Document trail for an example CFG - Validator's report. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | 99490026/R36 | Intern assessorapport IC 4 programmet CFG-DSB0065 Aflastningsventil | hard | | 15-Dec-10 | DSB | 06-Jul-11 | **177** | Production | Document trail for an example CFG - Assessor's report. |
| AB | | Presentation - Meeting with Atkins, Pistoia, July 20th, 2011 | pdf | | 20-Jul-11 | AB | 20-Jul-11 | **178** | Contractual | Presentation by AB to Atkins on 20 Jul 11 on the IC4 and IC2 projects. |
| AB | | Minutes of Meeting IC4-NT Upgrade, project status meeting # 1 | pdf | | 09-Feb-11 | DSB | 25-Jul-11 | **179** | Contractual | Minutes of AB/DSB TM NT Upgrade project meeting no. 1 |
| AB | | Minutes of Meeting IC4-NT Upgrade, project status meeting # 2 | pdf | | 09-Mar-11 | DSB | 25-Jul-11 | **180** | Contractual | Minutes of AB/DSB TM NT Upgrade project meeting no. 2 |
| AB | | Minutes of Meeting IC4-NT Upgrade, project status meeting # 3 | pdf | | 14-Apr-11 | DSB | 25-Jul-11 | **181** | Contractual | Minutes of AB/DSB TM NT Upgrade project meeting no. 3 |
| AB | | Minutes of Meeting IC4-NT Upgrade, project status meeting # 4 | pdf | | 17-May-11 | DSB | 25-Jul-11 | **182** | Contractual | Minutes of AB/DSB TM NT Upgrade project meeting no. 4 |
| AB | | Minutes of Meeting IC4-NT Upgrade, project status meeting # 5 | pdf | | 15-Jun-11 | DSB | 25-Jul-11 | **183** | Contractual | Minutes of AB/DSB TM NT Upgrade project meeting no. 5 |
| AB | | Presentation - Project meeting # 6 AB / DSB TM Randers 07.07.2011 | pdf | | 07-Jul-11 | DSB | 25-Jul-11 | **184** | Contractual | Presentation by DSB TM to AB on NT upgrades at project meeting on 07 Jul 11. |
| AB | T24433-061 | Umpire Report - Trainset 43 - Final Closeout Inspection - Aarhus Sonnesgade, 22nd March 2011 | pdf | | 23-Mar-11 | IT | 25-Jul-11 | **185** | Quality | Umpire's report on final close-out inspection in Århus Sonnesgade for trainset 43. |
| AB | T24433-079 | Umpire Report - Trainset 60 Delivery & Walkthrough Inspections at DSB Facility in Aarhus (Augustenborggade), 04 & 06 July 2011 | pdf | | 07-Jul-11 | IT | 25-Jul-11 | **186** | Quality | Umpire's report on delivery and walkthrough inspections in Århus Augustenborgadde for trainset 60. |
| DSB | | IC4 Produktionsplan 1 spor 74-9-12 05-2011 | xls | 1 | | DSB | 28-Jul-11 | **187** | Production | DSB Pack 1 production plan/resource schedule. |
| DSB | | IC4 produktion organisering | ppt | | 2011 | DSB | 28-Jul-11 | **188** | Organisational | DSB IC4 Production organisation chart. |
| DSB | | Working relationships for IC4 modifications | ppt | | | DSB | 28-Jul-11 | **189** | Organisational | DSB IC4PT working relationships. |
| DSB | | Risikolog for leveringsplan for MPTO togsæt til passagertrafik | doc | 23 | 28-Jul-11 | DSB | 28-Jul-11 | **190** | Safety | Risk log for delivery plan for placing MPTO trains in passenger traffic. |
| DSB | | Nødvendig ressourceudvidelser for IC4 idræftsættelse i trafik | ppt | 2 | | DSB | 28-Jul-11 | **191** | Organisational | Presentation on additional operations and maintenance resource requirements for IC4 commissioning and traffic. |
| DSB | | Necessary resource increases for successful commissioning of IC4 in traffic | ppt | 2 | | DSB | 28-Jul-11 | **191E** | Organisational | English translation of URN 191. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | Specialopfølgning DTO konklusion juni 2011 | pdf | | 19-Jul-11 | DSB | 29-Jul-11 | **192** | Reliability | DTO data monitoring for June 2011 |
| DSB | | IC4 DTO konklusion juni 2011 | pdf | | 25-Jul-11 | DSB | 29-Jul-11 | **193** | Reliability | DTO data report for June 2011. |
| DSB | | Referat DTO månedsmøde juni IC4 | doc | | 21-Jul-11 | DSB | 29-Jul-11 | **194** | Reliability | Notes of DTO Monthly Meeting - June 2011. |
| DSB | AA01U95<br>AA01K69 | Drawing - Four Train Set Layout<br>Drawing - Underframe Layout | pdf | C<br>3 | 26-Sep-01<br>14-Mar-02 | AB | 29-Jul-11 | **195** | Technical | IC4 general arrangement drawings - exterior and underframe equipment layout. |
| DSB | | Drifts pakke samt Pakke 3 Eng+TCMS_050411FLVJ | pdf | | 05-Apr-11 | DSB | 29-Jul-11 | **196** | Technical | Review of Pack 3 Engineering & TCMS with Known Issues list 240810 and TCMS Pack 3 AB Baseline 030311. |
| DSB | | Contract – GTA DMU type 1 | pdf | | 11-Dec-00 | DSB | 01-Aug-11 | **197** | Contractual | Original IC4 GTA procurement contract for 83 x 4-car trainsets and an option for a further 67 trainsets. |
| DSB | | Addendum to Contract of 11 December 2000 - Execution Copy 19 May 2009 | pdf | | 19-May-09 | DSB | 01-Aug-11 | **198** | Contractual | Addendum to original IC4 GTA contract comprising the 'Settlement Agreement'. |
| DSB | | IC2 Kontrakt Dansk | pdf | | 05-Nov-02 | DSB | 01-Aug-11 | **199** | Contractual | Original IC2 procurement contract for 23 x 2-car trainsets and an option for a further 97 trainsets. |
| DSB | | Addendum to Contract of 5 November 2002 - Execution Copy 1 July 2009 | pdf | | 01-Jul-09 | DSB | 01-Aug-11 | **200** | Contractual | Addendum to original IC2 contract comprising the 'Settlement Agreement'. |
| DSB | | Agreement for the Development, Installation and Software Maintenance of the Train Computer Management System - Execution Version | pdf | | 19-Nov-09 | DSB | 01-Aug-11 | **201** | Contractual | TCMS Upgrade and Technical Support contract. |
| DSB | AA07189 | Design Configuration Document and Train Version Identification for Multiple Train Profile | pdf | 10 | 26-Feb-10 | AB | 02-Aug-11 | **202** | Technical | Defines the train design configuration for Multiple Train Profile (update of URN 020). |
| DSB | P000217963 | IC4 Programmet DCD Konfigurationsdokument for - IC4, 3. Generation - | doc | 00 | 23-May-11 | DSB | 02-Aug-11 | **203** | Technical | DCD for IC4, 3. Generation (MPTO Pakke 2, drift) |
| DSB | P000180307 | IC4 Engineering milepælsoversigt over delprojekter | xls | | | DSB | 02-Aug-11 | **204** | Production | IC4 engineering milestone overview of sub-projects (with English translation of sub-project titles). |
| DSB | CR-DSB-01 | Att 1.2 - Tech items to be in SW Pack 2 | xls | | | DSB | 02-Aug-11 | **205** | Production | List of issues and possible solutions for TCMS Pack 2. |
| DSB | | Sub Appendix 2.1_rev29jul09 | xls | 29 | Jul-09 | DSB | 02-Aug-11 | **206** | Production | Coupling validation in TCMS for 2 trainset multiple operation |
| DSB | | Experience in service Pack-1 rev6_5 (di Paolo 27.06.2011) | xls | 6 | | AB | 02-Aug-11 | **207** | Production | Service experience with TCMS Pack 1. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | Quality Tracking Report | xls | | 18-Jul-11 | DSB | 02-Aug-11 | **208** | Quality | Tracking report for quality issues from pre-panel inspection through to takeover +1 month. |
| DSB | | Time Tracking Report | xls | | 18-Jul-11 | DSB | 02-Aug-11 | **209** | Production | Tracking report for production dates from shipment through to takeover +1 month. |
| DSB | | Strategi-slides - mod pakke 2 | ppt | | 21-Jun-11 | DSB | 02-Aug-11 | **210** | Approval | Strategy for Authority Approvals for Packs 1, 2, and 3. |
| DSB | | CFG Categories-Eng AVJ 020811 | pdf | | 02-Aug-11 | DSB | 02-Aug-11 | **211** | Technical | English translation of CFG categories. |
| DSB | | Pakke 2 CFGs AVJ 020811 | pdf | | 02-Aug-11 | DSB | 02-Aug-11 | **212** | Technical | Draft list of CFGs for Pack 2. |
| DSB | ARH/OIL/IC4 - 52 | AB ARH-OIL-IC452 Rev2 P4 | pdf | 2 | 25-Jul-11 | AB | 02-Aug-11 | **213** | Quality | Open items list form inspection for trainset 52. |
| DSB | | Payments Schedule for IC4 | hard | | | DSB | 03-Aug-11 | **214** | Contractual | Payments schedule for IC4. |
| DSB | | Payments Schedule for IC2 | hard | | | DSB | 03-Aug-11 | **215** | Contractual | Payments schedule for IC2. |
| DSB | | GTA Appendix 4 Availability Performance Requirements | doc | 1 | | DSB | 03-Aug-11 | **216** | Contractual | Appendix 4 to the original IC4 GTA contract covering availability, reliability, and maintainability requirements. |
| DSB | | IC3 DTO record jan09 | pdf | | 11-Feb-09 | DSB | 03-Aug-11 | **217** | Reliability | IC3 DTO Report for Jan 09. |
| DSB | DSB-IC4-P000218594 | Letter DSB to AB "DSB comments to STP 158 Train configuration updating" | doc | | 17-Jun-11 | DSB | 03-Aug-11 | **218** | Contractual | Correspondence from DSB to AB re acceptance by DSB of this updated document. |
| DSB | STP 158<br>AA07CA5 | Technical Production Specification - TRAIN Configuration Updating<br>PRODUCTION PROCESS and DEFINITION OF CONTROL/TESTING PHASES | pdf | 07 | 19-May-11 | AB | 03-Aug-11 | **219** | Production | Production specification for AB production processes in Italy and Denmark up to DSB Takeover. |
| AB | | Photographs of AB plant at Piacenza | hard<br>pdf | | | AB | 20-Jul-11 | **220** | Information | Photographs of AB's plant at Piacenza. |
| AB | | Diagram of IC4 Production area at Pistoia | hard<br>pdf | | 13-Jul-11 | AB | 20-Jul-11 | **221** | Production | Diagram of IC4 production area at Pistoia. |
| AB | | SITAV brochure | hard<br>pdf | | | AB | 20-Jul-11 | **222** | Information | Brochure describing the SITAV facilities at Piacenza. |
| DSB | | LCC REV 14 2008.10.31_official source file | xls | 14 | 31-Oct-08 | AB | 04-Aug-11 | **223** | Reliability | AB's life cycle cost (LCC) model. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | STE RAM AA02ENE | LCC Status Report Rev 14 2008.10.31 | pdf | 14 | 31-Oct-08 | AB | 04-Aug-11 | **224** | Reliability | AB report on the life cycle cost status. |
| DSB | F4 04 L1 | RAILWAY Applications - Breda Ferroviaria Power Pack - PPVZ2883*Q400 PPVZ2883*Q440 - Training Handbook | pdf | | Jun-06 | AB | 04-Aug-11 | **225** | Technical | Although regarded as an AB document, it is actually prepared by FPT Powertrain Technologies. |
| DSB | | Trainset 61 Inspection Log / Inspection Plan / HP4 Status / Pre-Pan & ATC Status | xls | | 03-Aug-11 | DSB | 04-Aug-11 | **226** | Quality | Tracking log for inspection of trainset 61. |
| DSB | | Appendix 1.6 IC2-MPTO Train Master Plan | pdf | FINAL | 26-Jun-09 | DSB | 04-Aug-11 | **227** | Contractual | Appendix to the IC2 Settlement Agreement (URN 200) comprising the trainset delivery schedule. |
| DSB | | IC2 status juni 2011 | pdf | | Jun-11 | DSB | 04-Aug-11 | **228** | Production | Presentation on the status of the IC2 project as at Jun 11. |
| DSB | | Contract on DSB Train Maintenance's Upgrading of 14 NT-Train Units - Execution Version | pdf | | | DSB | 05-Aug-11 | **229** | Production | Contract between AB and DSB TM for the NT trainset upgrade at Randers. |
| DSB | | Produktions - og indsættelsesplan for MPTO togsæt til passagertraffik | hard | 53 | | DSB | 28-Jul-11 | **230** | Production | Production and deployment plan for placing MPTO trains into passenger traffic. |
| TS | T541-000765 DOK1058855 | Forslag vedr. ansøgning om Type Approval august 2010 | pdf | | 16-Sep-10 | TS | 08-Aug-11 | **231** | Approval | Note "Proposal concerning application for Type Approval in August 2010". |
| TS | T541-000765 DOK1054331 | Generic Type Approval August 2010 | pdf | | 31-Aug-10 | TS | 08-Aug-11 | **232** | Approval | Note to DSB IC4 Project. |
| DSB | | DTO Monthly Meeting IC4 July 2011 | doc | | 11-Aug-11 | DSB | 18-Aug-11 | **233** | Reliability | Notes of DTO Monthly Meeting - July 2011. |
| DSB | | DTO Monthly Meeting IC4 July 2011 | doc | | 11-Aug-11 | DSB | 18-Aug-11 | **233E** | Reliability | English translation of URN 233. |
| DSB | | DTO Conclusions July 2011 | pdf | | 16-Aug-11 | DSB | 18-Aug-11 | **234** | Reliability | DTO data report for July 2011. |
| DSB | | DTO MG Monitoring of MPTO1 and NT+4 Trainsets for July 2011 | pdf | | 09-Aug-11 | DSB | 18-Aug-11 | **235** | Reliability | DTO data monitoring for July 2011. |
| DSB | | Settlement rabat 19-08-2011 | xls | | 19-Aug-11 | DSB | 19-Aug-11 | **236** | Contractual | Settlement rebates as at 19 Aug 11. |
| DSB | | AB TCMS payments - package 1 and 2 | xls | | | DSB | 19-Aug-11 | **237** | Contractual | TCMS payments schedule. |
| DSB | | 2011 IC4 rapportering samlet version juli | xls | | 31-Jul-11 | DSB | 23-Aug-11 | **238** | Operational | IC4 Operations report, July 2011 showing day by day status of each unit and traffic incidents/delays. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | IC4 togsætstatus | xls | | 25-Aug-11 | DSB | 25-Aug-11 | **239** | Production | IC4 train status as at 25 Aug 11. |
| | | | | | | | | **240** | Not used | |
| | | | | | | | | **241** | Not used | |
| DSB | | GTA Appendix 6 Technical systems requirements | doc | | | DSB | 01-Sep-11 | **242** | Contractual | Technical specification for systems from original contract. |
| DSB | | GTA Appendix 6-0 Vehicle Engineering | doc | | | DSB | 01-Sep-11 | **243** | Contractual | Technical specification for vehicle engineering from original contract. |
| DSB | | GTA Appendix 6-1 Carbody | doc | | | DSB | 01-Sep-11 | **244** | Contractual | Technical specification for carbody from original contract. |
| DSB | | GTA Appendix 6-2 Bogies and Running Gear | doc | | | DSB | 01-Sep-11 | **245** | Contractual | Technical specification for bogies and running gear from original contract. |
| DSB | | GTA Appendix 6-3 Power Supply | doc | | | DSB | 01-Sep-11 | **246** | Contractual | Technical specification for power supply from original contract. |
| DSB | | GTA Appendix 6-4 Propulsion | doc | | | DSB | 01-Sep-11 | **247** | Contractual | Technical specification for propulsion from original contract. |
| DSB | | GTA Appendix 6-5 Auxiliaries | doc | | | DSB | 01-Sep-11 | **248** | Contractual | Technical specification for auxiliaries from original contract. |
| DSB | | GTA Appendix 6-6 Brakes | doc | | | DSB | 01-Sep-11 | **249** | Contractual | Technical specification for brakes from original contract. |
| DSB | | GTA Appendix 6-7 Interiors | doc | | | DSB | 01-Sep-11 | **250** | Contractual | Technical specification for interiors from original contract. |
| DSB | | GTA Appendix 6-8 Control and Communication | doc | | | DSB | 01-Sep-11 | **251** | Contractual | Technical specification for control and communication from original contract. |
| DSB | | GTA Appendix 6-9 Specials | doc | | | DSB | 01-Sep-11 | **252** | Contractual | Technical specification for specials from original contract (the document has no content). |
| DSB | AA03ALD rC T841 680R02 | System Description for Platform Detection System (PDS) | pdf | C | 22-Apr-03 | IFE | 01-Sep-11 | **253** | Technical | System description of the Platform Detection System (PDS) fitted to exterior door footsteps. |
| DSB | T411272R03 | Door Function Description for Double Leaf Passenger Doors and Single Leaf Loading Doors | pdf | J | 25-Jul-08 | IFE | 01-Sep-11 | **254** | Technical | Functional description of external door system. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | T411272R09 | Maintenance Plan for Double Leaf Sliding Plug Door for IC4 High Floor | pdf | B | 24-Jul-08 | IFE | 01-Sep-11 | **255** | Technical | Maintenance plan for exterior doors - high floor. |
| DSB | T411272R13 | Door Diagnostic Description for Double / single leaf sliding plug door | pdf | E | 22-Mar-07 | IFE | 01-Sep-11 | **256** | Technical | Diagnostic description for exterior doors. |
| DSB | AA02A22 E303191R01 | Wiring Diagram - Sliding Plug Door | pdf | 10 | 18-Dec-06 | IFE | 01-Sep-11 | **257** | Technical | Wiring diagram for exterior doors. |
| DSB | AA03Y1T | External and Internal Doors and Departure Procedure Subsystem Functional and Design Description | pdf | 4 | 17-Oct-08 | AB | 01-Sep-11 | **258** | Technical | Functional and design description of door systems. |
| DSB | AA02A9W | Drawing - Movable Step Application | pdf | 8 | 08-Jul-06 | AB | 01-Sep-11 | **259** | Technical | Drawing of exterior door footstep installation |
| DSB | | DTO gennemgang 170811 | pdf | | 17-Aug-11 | DSB | 01-Sep-11 | **260** | Reliability | Flowchart for DTO and associated functions. |
| DSB | | DTO review 170811 | pdf | | 17-Aug-11 | DSB | 12-Sep-11 | **260E** | Reliability | English translation of URN 260. |
| DSB | | Behandling af forsinkelser og nedbrud I DTO | pdf | | 16-Oct-09 | DSB | 01-Sep-11 | **261** | Reliability | Definitions and handling of breakdowns and delays in the DTO system. |
| DSB | | DSB train maintenance | docx | | 16-Oct-09 | DSB | 12-Sep-11 | **261E** | Reliability | English translation of URN 261. |
| DSB | | Presentation of IC2 Programme to Atkins | ppt | | 05-Sep-11 | DSB | 06-Sep-11 | **262** | Contractual | Presentation to Atkins on 06 Sep 11 of the IC2 programme. |
| DSB | | IC2 Authority Approval 05-09-2011 for DSB | mpp | | 05-Sep-11 | DSB | 06-Sep-11 | **263** | Approval | DSB plan for type approval and running permits for IC2. |
| DSB | | IC2 Train # 4 delivery draft plan 05-09-2011 | mpp | | 05-Sep-11 | DSB | 06-Sep-11 | **264** | Production | DSB draft plan for delivery of IC2 trainset no. 04. |
| DSB | | Plan for MPTO togsæt til passtrafik IC4 ver 58 draft | xls | 58 | | DSB | 06-Sep-11 | **265** | Production | Draft plan for delivery of MPTO trainsets to traffic with Winter Pack 2 and then full Pack 1+2 modifications. |
| DSB | | 20110905 SIG SC tidsplan TCMS 2+2D | pdf | | 05-Sep-11 | DSB | 06-Sep-11 | **266** | Approval | Plan for safety approval for Pack 2 TCMS and Engineering. |
| DSB | P000217963 | DCD for 3. Generation, MPTO Pakke 2 drift | doc | 00 | 01-Sep-11 | DSB | 06-Sep-11 | **267** | Production | DCD for trainsets with Pack 2. Annex C lists the Winter CFGs and additional CFGs for the full Pack 2. |
| DSB | P000217963 | DCD for 3. Generation, MPTO Pakke 2 drift page 14, Annex C: Listing of changes | doc | 00 | 01-Sep-11 | DSB | 06-Sep-11 | **267E** | Production | Translation of URN 267 Annex C. |

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|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | GTA Appendix 6 Technical systems requirements - Sub Appendix 6N Requirements for coupling and de-coupling of train set | doc | | | DSB | 06-Sep-11 | **268** | Technical | Technical specification for the coupling and uncoupling of trainsets from the original contract requiirements. |
| DSB | P000218432 | Procedure filter ændringer | doc | | 14-Jun-11 | DSB | 08-Sep-11 | **269** | Technical | Procedure for admission of filter rules in IC4 IDU alarm filter. |
| DSB | IC4-4649 | IDU-log Statistic Report for IC4 MPTO P1 Trains in Service | pdf | A | 02-Sep-11 | DSB | 08-Sep-11 | **270** | Reliability | IDU-log Statistic Report |
| DSB | IC4-4649 Appendix | Statistical data from the IC4 Statistical Database | pdf | A | 02-Sep-11 | DSB | 08-Sep-11 | **271** | Reliability | Statistical data for A and B alarms from MPTO P1 trainsets in passenger service from 17-Jan-11 to 28-Jul-11. |
| DSB | | Drifts teknisk team | ppt | | | DSB | 09-Sep-11 | **272** | Organisational | Presentation (3 slides) of proposed development of the Drift Teknisk team. |
| DSB | | IC4 Drifts Teknisk Team præsentation | ppt | | 16-Jun-11 | DSB | 09-Sep-11 | **273** | Organisational | Presentation (3 slides) of Drift Teknisk team workstreams. |
| DSB | XHESA0101 I13 - 13.1 | 13.1 Driftteamet | pdf | 1.1 | 04-May-11 | DSB | 09-Sep-11 | **274** | Organisational | Paper (1-page) setting out the objectives, management, and organisation of the Drift team. |
| DSB | | Brake system_analisi Fault | xls | | | DSB | 09-Sep-11 | **275** | Reliability | Spreadsheet analysing brake system faults. |
| DSB | | PP fault_analisi | xls | | | DSB | 09-Sep-11 | **276** | Reliability | Spreadsheet analysing powerpack faults. |
| DSB | | IC4 Estimering iht udtræk tz 24_32_35 01022011_31072011 | rar | | | DSB | 09-Sep-11 | **277** | Reliability | Reliability performance analysis for 3 trainsets from 01-Feb-11 to 31-Jul-11 and improvement prediction for Packs 2D, 2.1, and 2.2. |
| DSB | | Senelec Struktur | xls | 2 | | DSB | 12-Sep-11 | **278** | Technical | Lists Cenelec codes applicable to IC4. |
| DSB | | Meeting with IFE concerning new SW/HW items held at Sonnesgade on 31 March 2011 | pdf | | 01-Apr-11 | DSB | 14-Sep-11 | **279** | Reliability | Meeting to discuss 5 planned modifications and 3 other issues. |
| DSB | | GTA Sub-Appendix 10b - List of sub-suppliers of main components. | doc | | 18-Sep-00 | AB | 14-Sep-11 | **280** | Contractual | List of proposed sub-suppliers (alternatives in some categories) of main components of IC4. |
| DSB | T003450R07 | Drawing of High Floor Footstep | pdf | 4 | 30-Sep-04 | AB | 14-Sep-11 | **281** | Technical | Drawing of IC4 high floor footstep arrangement. |
| DSB | | 2011 IC4 rapportering samlet version august - Atkins | xls | | | DSB | 21-Sep-11 | **282** | Operational | IC4 Operations report, August 2011 showing day by day status of each unit and traffic incidents/delays. |
| DSB | | Stock-flow-diagram 2011-09-15.xls | xls | | 15-Sep-11 | DSB | 21-Sep-11 | **283** | Production | Status of AB production as at 15 Sep 11. |

| Source | Document Ref. | Document Title | Format | Rev | Date | By | Date Received | URN | Category | Document Content |
|---|---|---|---|---|---|---|---|---|---|---|
| DSB | | IC4-IC2 Review MPTO P1 Operating Feb-Aug 11 (Filled out).xlsx | xls | | 22-Sep-11 | DSB | 22-Sep-11 | **284** | Reliability | Operational performance of MPTO P1 trainsets in passenger service from Feb 11 to Aug 11. |
| DSB | | Reliability Prediction | xlsx | | 16-Sep-11 | DSB | 16-Sep-11 | **285** | Reliability | Reliability performance analysis for 6 trainsets from 01-Feb-11 to 31-Aug-11 and improvement prediction for Packs 2D, 2.1, and 2.2. |

# A 4 Question / Answer Log

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP001** | 29-Jun-11 | | Atkins / DSB Introductory Meeting | | 29-Jun-11 | DSB specified that IC4 was to achieve a 1 hour journey time between the main 3 cities. Did the AB offer comply?<br>Does IC3 meet this requirement or is IC4 specified to have a higher performance than IC3. | 26-Jul-11 | The "1 hour" model is a political vision introduced years after signing of the IC4 contract, as such it hasd not been part of the contract requirements between DSB and AB. Requirements included in the IC4 contract for journey times was part of the contract but have now been eliminated as part of the settlement. If Atkins wishes to receive the original travel time requirements please inform. | Closed |
| **KP002** | 29-Jun-11 | | Atkins / DSB Introductory Meeting | | 29-Jun-11 | What were the original design issues concerning bodyside window sizes and exterior door locations?<br>How were these resolved?<br>What were the impacts on the project schedule in terms of time and costs and bodyshell structural design? | 26-Jul-11 | This issue was settled before the settlement. As such it does not have an impact on current delivery schedule. | Closed |
| **KP003** | 29-Jun-11 | | Atkins / DSB Introductory Meeting | | 29-Jun-11 | Can we have a clear and simple table that defines the various train configurations NT, NT+, NT++, MPTO, MPTO Pack 1, MPTO Pack 2, and MPTO Pack 3 with the applicable DCD references for each configuration (URN 013 AA07CA5 refers to AA056WX, AA07186, AA07189)?<br>How do these relate to the configuration references in URN 007 AQU IO/045 rev 22/AE of "Pack 6", "Pack 7 NT", "Pack 7 NT+", "Pack 7 C-MTTA", and "Pack 7 MPTO Pakke 1"? | 30-Jun-11 | DCD documents provided to Atkins by DSB including URNs 015/019/020/021 | Closed |
| **KP004** | 29-Jun-11 | | Atkins / DSB Introductory Meeting | | 29-Jun-11 | DSB to provide a schedule of payments made to date by DSB to AB for work done by AB to DSB for compensation under the original contract and then under the Settlement Agreement. DSB to provide a planned schedule of payments to be made by DSB to AB for work done to the end of the current contract. What further financial liabilities is AB carrying under the Settlement Agreement that could result in additional compensation payments by AB to DSB? | 03-Aug-11 | Docouments provided by DSB (URNs 214 / 215) at meeting with Anders Hylleberg. | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP005** | 30-Jun-11 | **007** | AQU IO/045 | 22/AE | 07-Oct-10 | Can we have copies of documents referenced in URN 007 as per the list tabled at the Atkins/DSB Meeting on 30 Jun 11? | 30-Jun-11 to 05-Jul-11 | Documents provided by DSB. | Closed |
| **KP006** | 30-Jun-11 | | Atkins / DSB Introductory Meeting | | 30-Jun-11 | Can we have copies of documents covering a Technical Description of the train, General Arrangement Drawings of the train, a list of Known Issues and CFGs, and the Train delivery schedule? | 30-Jun-11 to 01-Jul-11 | Documents provided by DSB. | Closed |
| **KP007** | 01-Jul-11 | | Atkins / DSB Introductory Meeting | | 01-Jul-11 | Can we have a copy of the Quality Procedure covering project documentation registration? | 01-Jul-11 | "IC4 Dokumentation" ref XHESA0101 rev 1.9 dated 20-Jun-11 provided and logged as URN 039. | Closed |
| **KP008** | 03-Jul-11 | **026** | Deloitte Report | | Mar-11 | Have the report recommendations been accepted and implemented by AB and DSB, what actions have been completed to date, and what is the future action plan? | 20-Jul-11 | Copy of AB's response to Report provided (URN 040) by DSB and discussed with AB in Pistoia. | Closed |
| **KP009** | 04-Jul-11 | | | | | What failure rate in terms of 'kms / 5 minute delay' was IC4 expected to achieve when the original contract was awarded in 2000? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. Expectation was to achieve at least parity with IC3 at 20k - 30k 'kms/delay", but the contractual traffic requirements were expressed in the LCC Model completed by AB (see URNs 223/224). Meeting those requirements would enable DSB to meet its obligation for 93% puncutality across long-distance and regional trains. However, AB were relieved of the LCC obligation under the Settlement Agreement. | Closed |
| **KP010** | 04-Jul-11 | | | | | What failure rate in terms of 'kms / 5 minute delay' would IC4 have to achieve to be regarded by DSB as a success? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. IC4 should achieve parity with IC3 or at least 20k 'kms/delay'. | Closed |
| **KP011** | 04-Jul-11 | | | | | What failure rate in terms of 'kms / 5 minute delay' would IC4 have to achieve to be regarded by DSB as tolerable? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. At least 15k 'kms/delay' would be required to avoid adverse impact upon the punctuality figures. | Closed |
| **KP012** | 12-Jul-11 | | AA07189 | Rev 10 | | Can DSB provide a copy of AA07189 at Rev 10 (we already have Rev 9 as URN 020)? | 02-Aug-11 | Document provided by DSB (URN 202). | Closed |
| **KF013** | 13-Jul-11 | | | | | What IC4 maintenance facilities are available in addition to Århus, what work is planned at these facilities, and what is their capacity and resources? | 28-Jul-11 | DSB stated at meeting held at Århus that there are none at present, but it is planned to undertake 15k exams at Copenhagen and to work towards a balanced 45k exam regime at Århus. | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KF014** | 13-Jul-11 | | | | | What shift patterns are worked at Århus for preventive and corrective maintenance? | 28-Jul-11 | DSB stated at meeting held at Århus that it is 3 x 8hr shifts from 15:00h Sunday to 15:00h Friday plus Saturday 07:00h - 15:00h, i.e. 15 x 8hr shifts per week. | Closed |
| **PF015** | 13-Jul-11 | **141** | | | 29-May-11 | What data was used for the reliability predictions in this report? | 29-Jul-11 | Discussed with Steen L Andersen at Århus. | Closed |
| **PF016** | 13-Jul-11 | **141** | | | 29-May-11 | What MPTO failures from Jan 11 to Jun 11 are not covered by the Pakke 2 modification programme? How will these failures be investigated and solutions implemented and how will the implementation be prioritised? What is the 'staff to issue ratio? | 02-Aug-11 | Discussed at meeting with Lars Slott Jensen and Allan Victor Jensen. | Closed |
| **KP017** | 13-Jul-11 | **141** | | | | What will be the impact on the current IC4 reliability of more frequent coupling and uncoupling in service as more IC4 trains enter traffic and Pakke 2 is approved for 3 train sets coupled? | 02-Aug-11 | Discussed at meeting with Lars Slott Jensen and Allan Victor Jensen. Coupling and uncoupling has not been undertaken in passenger service so the potential failjure rate is unknown. | Closed |
| **PF018** | 13-Jul-11 | **141** | | | 29-May-11 | We have been advised that wheel wear and frequency of tyre-turning is due to wheelslides. Are there any indications of rolling contact fatigue (RCF)? Has the current rate of tyre-turning and consequential loss of wheel life been compared with other fleets? | 29-Jul-11 | Discussed with Steen L Andersen at Århus. There are issues with the wheel tread condition and this is being investigated by DSB's wheelset specialists. | Closed |
| **PF019** | 13-Jul-11 | | | | | What is the critical path for getting spare parts onto the stores shelves? | 28-Jul-11 | Discussed with Benni H Nissen at Århus. Additional resources are to be provided for spares management and the ncritical path thereafter is likely to be the lead times for critical spares. | Closed |
| **PF020** | 13-Jul-11 | | | | | In 2 months there will be approximately 2,500 spare parts registered in SAP. Of these, how many have an organised supply chain now, how many in 2 months time, and how many in each 2 months after that? | 28-Jul-11 | Discussed with Benni H Nissen at Århus. 145 spares are currently programmed into the supply chain with another 205 to be completed in 1 week. Thereafter each batch of 200-300 parts should take around 2-3 weeks or around 3-5 months in total. | Closed |
| **PF021** | 13-Jul-11 | | | | | How many more staff are required to meet the present requirements for trouble-shooting and corrective maintenance as well as preventive maintenance and how will this increase as the full fleet of 83 train sets enters traffic? | 28-Jul-11 | Discussed at meeting with Hans Jacob at Århus and a copy of his presentation regarding resources was provided to Atkins (URN 191). | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer |
|---|---|---|---|---|---|---|---|---|
| **KP022** | 13-Jul-11 | | | | | Why does the Operating Department require to operate IC4 train sets with 4 sets coupled, i.e. 16 car trains? | 08-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. This is required so that IC4 can operate under the same 'coupling strategy' as IC3 and IR4. The purpose is to provide sufficient passenger capacity between Kopenhagen Airport, Fredericia, and Århus and enable passengers to travel on to other destinations wothout changing trains. However, there may be viable alternatives to the coupling strategy for long distance trains given the present growth in passenger traffic. |
| **KP023** | 13-Jul-11 | | | | | Why does the Operating Department require coupling to be carried from 1 cab only? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. There is no such hard requirement, but the requirement for being able to couple (and uncouple) with one driver is not new. It is a requirement that is commonly requested by DSB during purchase. In order to comply to the required time for coupling it was necessary for AB to install a WiFi to ensure that time was saved in the process. Coupling can however be done without the WiFi, resulting in the need for two drivers or one driver have to move between the two units. When IC3s are coupled and uncoupled, there are always 2 drivers present. |
| **KP024** | 20-Jul-11 | | | | | Can DSB provide a copy of STP158 at Rev 7 (we have Rev 6 as URN 013)? | 03-Aug-11 | Document provided by DSB (URN 219). |
| **KP025** | 20-Jul-11 | | | | | Has DSB accepted STP158 at Rev 7? | 03-Aug-11 | The document remains under discussion between the two parties, ref. URN 218. |
| **KP026** | 20-Jul-11 | | | | | Can DSB provide a copy of AB's LCC model? | 04-Aug-11 | Discussed at meeting with Lars Slott Jensen on 03-Aug-11, copy of LCC model and explanatory document received 04-Aug-11. |
| **KP027** | 20-Jul-11 | | | | | AB stated (21-Jul-11) that DSB accepted the LCC model prediction of 246.37 traffic disturbances per 1 Mn kms, i.e. 4,065 km/incident, under the Settlement Agreement, is this correct? | 03-Aug-11 | AB's obligations regarding the LCC model were removed by the Settlement Agreement. |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP028** | 20-Jul-11 | **028** | | | | What requirements that were in the original contract specification will not be provided by the MPTO Pakke 2 design configuration? | 03-Aug-11 | Disucssed at meeting with Lars Slott Jensen. As the content of Pakke 3 is not yet developed and agreed, the eventual gap between the train configuration and the original specification is not known at this time. | Closed |
| **KP029** | 25-Jul-11 | **005**<br>**125**<br>**143**<br>**145** | | | 29-Jun-11<br>07-Jul-11<br>16-Jun-11 | Can DSB clarify the organisation, resources, facilities, and working relationships for modification, preventive maintenance, and corrective maintenance of the IC4 fleet? | 28-Jul-11 | Documents provided by DSB at meetings with Keld Eriksen, Hans Jacob, and Jes A Nielsen at Århus. | Closed |
| **KP030** | 25-Jul-11 | | | | | Can DSB provide a demonstration of train set coupling and uncoupling for Atkins to witness from within the cab and from the ground? | 28-Jul-11 | Demonstration provided by DSB at Århus. | Closed |
| **KP031** | 25-Jul-11 | **024**<br>**036** | | 51 | <br>02-Jul-11 | Can DSB clarify progress against the MPTO Pakke 1 and Pakke 2 implementation programmes and threats to on-time completion of the programmes? | 28-Jul-11 | Programme discussed at meeting with Lars Slott Jensen and Allan Victor Jensen at Århus. Copy of Pakke 2 risk assessment provided by DSB (URN 190). | Closed |
| **KP032** | 25-Jul-11 | | | | | Can DSB clarify the scope of work in each phase of the TCMS upgrade contract and progress against the planned schedule? | 02-Aug-11 | Discussed at meeting with Lars Slott Jensen and Inge Brandbye and relevant documentation provided. | Closed |
| **KP033** | 25-Jul-11 | | | | | Can DSB clarify the specific technical issues which are or will be addressed by the Pakke 1 and Pakke 2 programmes, new operating and/or technical issues for which CFGs are not yet planned, and expected reliability growth? | 02-Aug-11 | Discussed at meeting with Lars Slott Jensen, Allan Victor Jensen, and Inge Brandbye and relevant documentation provided. | Closed |
| **KP034** | 25-Jul-11 | | | | | Can DSB clarify the operating strategy for the IC4 and IC2 fleets including routes, journey times, service frequencies, passenger demands, and requirements for couplinh and uncoupling in service? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen, see separate Notes of meeting. | Closed |
| **KP035** | 25-Jul-11 | | | | | DSB to provide a copy of the Settlement Agreement. | 02-Aug-11 | Documents provided by DSB (URNs 198 / 200). | Closed |
| **KP036** | 25-Jul-11 | | | | | DSB to provide a copy of the TCMS Contract Agreement. | 02-Aug-11 | Document provided by DSB (URN 201). | Closed |
| **KP037** | 25-Jul-11 | | | | | Can DSB provide a copy of the NT Upgrade Contract Agreement? | 05-Aug-11 | Document provided by DSB (URN 229). | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP038** | 25-Jul-11 | **178** | | | | What is DSB's view of AB's presentations to Atkins on 20/21 Jul 11? | 03-Aug-11 | Discussed at meeting with Lars Slott Jensen and Anders Hylleberg. | Closed |
| **KP039** | 25-Jul-11 | | | | | Can DSB clarify the expected programme for delivery (takeover), upgrade, and introduction to service of the IC2 fleet? | 04-Aug-11 | Discussed at meeting with Lars Slott Jensen and Ken Busk scheduled for 04-Aug-11 and URN 228 provided. | Closed |
| **KP040** | 26-Jul-11 | **178** | | | 20-Jul-11 | Can AB clarify the reference to "New Settlement (now on-hold) *March-May 2011*" on Slide 5 of their presentation to Atkins? We do not recall seeing or discussing this item during the meeting and it is not explained on Slide 6. | 27-Jul-11 | Clarified at meeting with AB at Augustenborggade on 27-Jul-11. | Closed |
| **NB041** | 26-Jul-11 | | | | | Can DSB clarify the relationship between Atkins' IC4/IC2 Review and the parallel studies "Alternative stock strategies as a consequence of IC4" and "Electrification strategy" and the progress to date with these two other studies? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. DSB is not part of the 'Alternative strategies' working group although it is asked to provide input. DSB's view is that alternative strategies for rolling stock to replace IC4 are as per the Atkins "Plan B" Report of 2009. However, the current growth in passenger traffic may require a change to the passenger strategy for long distance and regional trains and, therefore, a change to the strategy for rolling stock introduction. | Closed |
| **KP042** | 26-Jul-11 | | | | | How frequently have MPTO train sets been coupled and uncoupled in normal passenger service from Jan 11 to date? Has the cab-to-cab wireless been used in all cases? If not, how frequently has the cab-to-cab wireless been used? | 28-Jul-11 | MPTO trains have not been coupled and uncoupled in passenger service. They have run as 2-train sets in passenger service (i.e. 8-car trains), but this has now been discontinued. | Closed |
| **KP043** | 27-Jul-11 | | | | | Can DSB provide a copy of the draft "New Settlement" agreements covering IC4, IC2, and TCMS, as discussed under Question KP040 above? | 04-Aug-11 | Not at this time. | Closed |
| **KP044** | 28-Jul-11 | | | | | How many staff at present undertake Preventive and Corrective Maintenance at Århus? | 28-Jul-11 | Hans Jacob stated at a meeting held at Århus that the current resource is 60 blue collar staff with 46 engaged in maintenance and 14 in simulation. | Closed |
| **KP045** | 28-Jul-11 | | | | | What is the ratio of Preventive Maintenance to Corrective Maintenance at present? | 28-Jul-11 | Hans Jacob stated at a meeting held at Århus that it is 50/50. | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP046** | 28-Jul-11 | | | | | How many train sets can be maintained by the present staff levels at Århus? | 28-Jul-11 | Hans Jacob stated at a meeting held at Århus that with the present resource (see Question KP044) up to 50 train sets can be maintained at Århus assuming 15k exams are undertaken elsewhere and that the ratio of Preventive to Corrective Maintenance is 70/30. | Closed |
| **KP047** | 29-Jul-11 | | | | | Why are there problems and delays with obtaining RTR permits, thus delaying the takeover programme? | 02-Aug-11 | Discussed at meeting with Lars Slott Jensen. There are 2 types of running permit that require TS approval:-<br>> RTR (Restricted Test Run) on closed track, required by AB for dynamic testing prior to takeover by DSB. This is time critical as it impacts on AB's delivery programme and the payments schedule.<br>> Passenger Service on open track, required by DSB before a train set is taken over by the Traffic Department. This is not time critical at present as there is a time lag of train sets awaiting Pakke 1 modification at Århus. | Closed |
| **KP048** | 02-Aug-11 | | | | | Will all overnight stabling locations for IC4 be equipped with shore supplies as a protection against damage in winter? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. DSB has already invested in and completed new maintenance and stabling facilities for IC4 including the provision of shore supplies. | Closed |
| **KP049** | 02-Aug-11 | | | | | How long will train sets stand in storage at Århus between takeover by DSB and completion of Pakke 1 and Pakke 2 modifications? Are they protected against damage due to non-operation? | 04-Aug-11 | Currently the general time from AB finalising a train set (Close out) until the set is brought into the upgrade production facility is about 12 weeks. Prior to the current set up, longer waiting times were experienced. It is expected that, with the increase in personnel and workshop ressources that waiting times will reduce, despite the increased work-load coming due to pack 2. Some train sets are deviating from these figures due to malfunctions (e.g. awaiting re-test due to not witnessing originsal tests) while other units are deviating due to use for other purposes (e.g. TCMS testing). | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP050** | 02-Aug-11 | | | | | Does DSB have an anti-graffiti programme covering protection against graffiti on trains and removal of graffiti? | 05-Aug-11 | Discussed at meeting with Frank Olesen and Lars Slott Jensen. DSB has an anti-graffiti programme consisting of: ASAP take the unit out of operation for graffiti removal. Before removal, register all graffiti in a database including tags, etc. Prosecute people who can be connected to specific graffiti tags and designs. | Closed |
| **KP051** | 09-Aug-11 | | | | | What exactly is the split in the scope of work and stages of IC2 production and testing between Pistoia and Montale? | 09-Aug-11 | The split in the scope of work of the IC2 production and testing is:-<br>> Montale site: coach assembly and wiring check (DRDT 01 and DRDT 02). All activities are performed at coach level.<br>> Pistoia plant: train composition, train level testing and HP4 inspection. | Closed |
| **KP052** | 09-Aug-11 | | | | | What impact will the IC2 work at Pistoia have on the continuing IC4 production and testing? | 09-Aug-11 | IC2 activities at Pistoia plant will be performed by using resources from the Montale sub-supplier, thus not causing any impact on the IC4 production. | Closed |
| **KP053** | 09-Aug-11 | | | | | Does this mean that additional tracks will be made available for Montale personnel to work on IC2 trains, i.e. additional to those identified as Bins 29 / 31 / 34 / 36 / 38 / 79 / 81 on the plan given to us during our visit? If so, when will this additional capacity become available? | 25-Aug-11 | AB will make available for the IC2 trains the track on the testing area that is long enough to host 1 IC4 and 1 IC2 train at the same time. This was already made for testing of IC2 prototypes. In addition AB will couple the IC2 train on the same track where they couple the IC4 train. The coupling phase for the IC2 lasts few days (one articulation only) and there is no need for a dedicated track. | Closed |
| **KP054** | 19-Aug-11 | | | | | How much of the budget for DSB IC4/IC2 engineering has been spent to date in total? | 22-Aug-11 | Information provided. | Closed |
| **KP055** | 16-Sep-11 | **271** | IC4-4649 | | | In addition to the list of total successful 'trips / breakdowns / cancellations' per trainset for the period Jan 11 – Jul 11, please provide additional information for 5 minute delays per trainset per month. | 22-Sep-11 | Information provided. | Closed |
| **KP056** | 16-Sep-11 | **238** | | | | Is a copy of the Aug 11 Operating Report available? | 21-Sep-11 | Document provided. | Closed |

| Question No. | Question Date | Doc. URN | Document Reference | Doc. Rev. | Document Date | Question | Answer Date | Answer | Q/A Status |
|---|---|---|---|---|---|---|---|---|---|
| **KP057** | 16-Sep-11 | | | | | Can an update of the number of IC4 and IC2 cars that have passed HP1, HP2, and HP3 stages in Italy and trainsets that have passed HP stage in Italy, shipped to Denmark, and taken over by DSB during Aug 11 be provided? | 22-Sep-11 | Information provided. | Closed |
| **KP058** | 16-Sep-11 | **214**<br>**215** | | | | Can an update of the total sum of payments made to AB excluding tax for IC4, IC2, TCMS, and spares as at 31 Aug 11 be provided? | 21-Sep-11 | Information provided. | Closed |
| **KP059** | 21-Sep-11 | | | | | Has the status of the NT upgrade programme changed since 31 Jul 11? | 22-Sep-11 | Updated information provided. | Closed |

# A 5 Reliability Improvement Team - Working Methodology and Implementation

Reliability Improvement Team

Working Methodology
and
Implementation

1

## Section 1 - Reliability Improvement Cycle Overview

- Reliability Improvement
- Reliability Improvement Cycle Overview
- Fleet Casualty Analysis and Improvement Process Cycle
- Information Sources
- Daily Actions – Process Faults Arising
- Key Inputs Into Periodic Fleet Analysis and the War Room
- Periodic Fleet Analysis, Meetings and Reporting
- Reliability War Room Organisation and Activities
- War Room Reliability Improvement Key Performance Indicators (KPIs)
- RAMS

3

SECTION 1

# RELIABILITY IMPROVEMENT CYCLE OVERVIEW

2

# Section 1 - Reliability Improvement

For all forms of traction and rolling stock, reliability improvement is a constant struggle over the entire life of the Units. Problems emerge and are dealt with to create a balance between rising failure rates and the cost and practicalities of implementing reliability fixes. The rate of reduction in failures must outweigh the increase in failures from existing and new issues for any net benefit to be achieved. Reliability improvement activities may reduce in the future as reliability improves but will remain ongoing for the life of the fleet.

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# Section 1 - Reliability Improvement Cycle

- Fleet Casualty Analysis and Improvement Process Cycle
  - This generic improvement cycle shown in the next two sheets shows the outline of a process which should be recreated in the structure of the organisation to generate improvements.

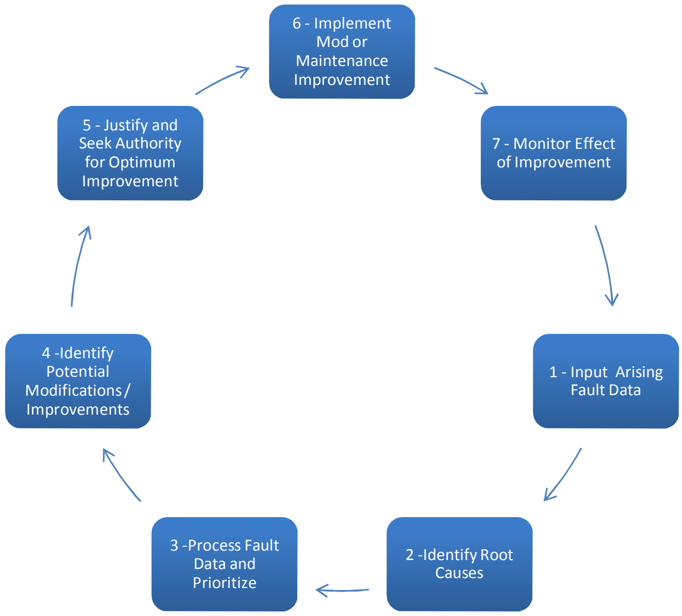
- The IC4 Reliability Improvement Process Flowchart shown in Appendix A of this report shows one means of how this process cycle can be applied to the existing organisation. The flowchart is separated into four areas as follows:-

  - Information Sources
  - Daily Actions – Process Faults Arising
  - Periodic Fleet Analysis and Reporting
  - Feedback (Post periodic analysis actions required to influence each teams activities towards optimising reliability improvement.)

These sheets follow on from the generic reliability improvement cycle.

1

## Section 1 - Fleet Casualty Analysis and Improvement Process Cycle

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## Section 1 - Fleet Casualty Analysis and Improvement Process Cycle Continued

- The cycle of implementing improvements dictates the rate of reduction in failures.
- The rate of reduction in failures must outweigh the increase in failures from existing and new issues for any net benefit to be achieved.
- The process must continue for the life of the vehicle to ensure that failure rates remain as low as practically possible.
- The rate of failure for some root causes will be controlled by the implementation of future heavy maintenance and overhaul tasks.
- These overhaul tasks may in turn may affect the rate of failures in future years to come.

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## Section 1 - Information Sources

- DTO - SAP
  - A system in place which provides good information covering the source, investigation and correction of a casualty. Primary deficiency is that root cause of a casualty is not always identified and subsequently faults are not categorised according to root cause.
- IDU Fault Logs
  - Valuable information currently used in the diagnosis of faults.
  - Automated download of IDU data would significantly reduce the day to day costs of data retrieval.
  - Automated analysis of the data could be developed to provide a cheap source of information to supplement fleet casualty analysis.
- Other Information Sources
  - Information from sources outside the direct control of the RIT are more difficult to control. The quality of reported information useful to the RIT (Reliability Improvement Team), may be improved by standardizing reporting templates used.

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## Section 1 - Daily Actions – Process Faults Arising

- The IC4 Reliability Improvement Organisational Flowchart shows a proposed organisational flow chart for the four teams which contribute to the reduction of casualties. The contributing teams are:-
  - Operations
  - Depot Drift Team
  - Reliability Improvement Team
  - Project Team
- The chart shows an outline of daily activities which the teams must carry out to achieve the common goal.
- Each team must capture information for their activities to feed into periodic analysis and the War Room. An outline of the key information gathered is shown in the following sheet.

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## Section 1 - Key Inputs Into Periodic Fleet Analysis and the War Room

- Reliability Improvement Team
  - Fleet casualties in a database separated into root causes and recording for each the impact on operations.
  - No Fault Found (NFF) failures should be separated out from the other casualties. NFF failures can be a large part of a fleets reliability and deserves separate analysis and actions to reduce their numbers.
  - Ideally, combined output from fleet fault logs should also feed into analysis process to provide an additional source of information for comparison.
- Project Team
  - Progress with known issues for which a solution has not yet been found.
  - Progress with modifications to reduce the frequency of known issues.
  - Progress with seeking authority for modifications which have been fully written and submitted.
  - For all known and unknown issues the target completion dates for activities must be estimated and put forward.
- Depot Drift Team
  - The depot will have an opinion and input into the reliability analysis process. Typically this will emerge from their own meetings which may also be held in the War Room.
- Operations
  - The number of fleet casualties which were not the result of a train failure should be separated into categories of root cause. Each category should be monitored and mitigated in a structured manner.
  - Operations will have an input into fleet reliability meetings in the War Room and should be involved with the periodic review process in the War Room.

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## Section 1 - Periodic Fleet Analysis, Meetings and Reporting

- Analysis
  - Information gathered by Operations and the RIT must be processed to provide an input into reports, discussions and the War Room.
  - The RIT team must sort all root causes into an order of impact on the service.
  - Each root cause must be categorised into their status in the development and implementation of corrective actions (See the stages of the “Fleet Casualty Analysis and Improvement Process Cycle” shown previously.
  - The latest plan for corrective actions and modifications should be applied to create a prediction of future reliability. This is discussed in greater detail later in this report.
- Reporting of progress provides an input into War Room discussions.
  - Reports prepared by the RIT and Operations should be circulated to all parties ideally a few days prior to each war room meeting. This is to allow all parties to prepare for the meeting in advance.
  - Similarly progress / inputs from the Project team and issues for discussion from the Drift Team should be circulated a few days in advance.
  - Structured reports input into the War Room will help all parties involved focus on the primary concerns and avoid lengthy discussions of current status and minor topics.

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## Section 1 - Reliability War Room Organisation and Activities

- Driving The War Room
  - Whilst all participants contribute to war room activities, it is considered appropriate for the war room to be driven by the RIT team leader.
  - Initial meetings should be set at two weekly intervals and adjusted as appropriate.
  - Timescales - The best way forward to achieve the required goal is normally an easily solved within a war room discussion. A more difficult topic and a common argument within the war room environment is the selection of appropriate timescales for completion of actions. The war room environment should where appropriate be a supportive environment encouraging all participants to contribute to the common goal and provide the shortest possible turn around of actions necessary to achieve this. It may become necessary to press harder for actions to be completed in some cases. Achieving this balance is a required skill of driving the war room.

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## Section 1 - Reliability War Room Organisation and Activities Continued

- The status of each root cause should be visible in the form of a summary representation on the wall.
- To aid clarity these root causes should be shown separated into categories according to which stage they are in in the cycle of improvement (for example modification authority being sought).
- The representation should show each root cause in order of impact on service (Prioritized).
- Progress from reports pre-prepared should be updated quickly and compared with previous predictions. Delays to the plan for progressing and implementing improvements can be discussed amongst the teams.
- The representation should show the current action holder for the improvement of each root cause and the planned date for the completion of this action.
- New root cause issues emerging should be discussed.
- Targets for each system (and the sum of their contributing root causes) should be discussed. Current progress towards achieving these targets should be discussed and potential corrective actions.

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## Section 1 - War Room Reliability Improvement Key Performance Indicators (KPIs)

- KPIs (Key Performance Indicators) – The progress of moving the reliability of each root cause to its target reliability are primary KPIs. Similarly the sum total of all root causes (Fleet Reliability) is an important KPI. Other KPIs listed below may be considered for the war room discussion.
  - The sum total of all NFF casualties, their impact on fleet reliability, how this NFF summary breaks down into individual causes and what is being done to minimise each cause.
  - Similarly, the sum total of all non train faults, their impact on fleet reliability, how these faults breaks down into individual causes and what is being done to minimise each cause.
  - The percentage of known root causes with respect to all faults.
  - The time taken to progress faults from root cause identification through all stages to the completion of applied mitigations.

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## Section 1 - RAMS

- RAMS - Reliability, Availability, Maintainability and Safety is covered by EN50126. This document covers these aspects over the life of the rolling stock from design concept through to disposal. There are elements within this document which should be considered particularly for safety related faults.

- This document focuses on the tackling reliability issues and shows that safety related faults should be highlighted for consideration immediately as they emerge and be considered as separate issues of higher priority within the reliability database and any reliability report based upon the database contents. The contents of EN50126 adds more detail not covered within in this document.

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SECTION 2

# IMPROVEMENT CYCLE ELEMENTS IN GREATER DETAIL

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## Section 2 - Improvement Cycle Elements in Greater Detail

The cycle of improvement previously shown contains the following elements.

- 1 - Input Arising Fault Data
- 2 -Identify Root Causes
- 3 -Process Fault Data and Prioritize
- 4 -Identify Potential Modifications / Improvements
- 5 - Justify and Seek Authority for Optimum Improvement
- 6 - Implement Mod or Maintenance Improvement
- 7 - Monitor Effect of Improvement

The following sheets aim to provide additional advice / suggestions regarding each element.

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## Section 2 - 1 Input Arising Casualty Data

- Input Arising Casualty Data
  - Attempt to streamline input from data sources (reduce workload and improve information). One means of achieving this is through education of all personnel who input supporting data to let them know the objective (identify root cause).
  - Place failure data into spreadsheet against root cause where possible.
  - The root cause code could be achieved with the addition of digits following the CENELEC code applied to each failure.
  - Where root cause is unknown, use CENELEC code and strive to clarify these additional digits for root cause.

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## Section 2 - 1 Input Arising Casualty Data Continued

IDU Fault Logs Current Use

- Currently the fault logs are used as a diagnostic tool and broadly to look for specific issues.
- Further use of the date to pick out a broad range of problems is hindered by the quantity and quality of the information.

IDU Fault Logs Potential Use

- It is understood that the IDU filter will greatly reduce the quantity and improve the quality of information.
- Additional filtering will continue this process of refinement.
- Automated processing of the data extracted may be applied to pick out problems and greatly reduce the current workload of browsing data.
- The filtered and processed information could be used to highlight faults (required actions) which:-
  - are a potential casualty – incidents which by chance did not cause a delay sufficient to result in a casualty.
  - are a safety related fault.
- Daily IDU automated downloads would greatly reduce workload and cost.

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## Section 2 - 2 Identify Root Causes

- Root Cause Analysis
  - Staff should be encouraged to ask themselves and as necessary supporting Engineering / suppliers why a system or component has failed repeatedly through all symptoms until they arrive at the root cause. The objective is to dig deep enough to remove layers of symptoms and identify the key variable which is the true source of the problem.
  - This summarises a methodology commonly referred to as the ‘5 whys’. There are other less obvious techniques (Ishikawa) which could be used but these are not recommended as they are more applicable to non technical problems.
  - Normally a methodical pursuit of a technical problem’s root cause will determine the path to take and dictate the actions necessary to pursue the answer to the next ‘why’.
  - Once the root cause is known, a unique code can be applied to it. As previously stated this could be additional letters behind the CENELEC coding currently used.
  - Each root cause becomes an individual row in the root cause database.

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## Section 2 - 2 Identify Root Causes Continued (No Fault Found Defects)

Fleet issues usually have a proportion of No Fault Found (NFF) defects. IC4 appears to have a larger proportion of NFF defects than would be considered usual. 40% was put forward by IC4DT in discussions. These defects should not be overlooked / excluded from analysis and action. It is recommended that analysis and discussion of these faults is carried out as a separate work stream to help ensure they are not overlooked. The following points are relevant for reducing the quantities of NFF defects:-.

- NFF defects should be captured and categorises to aid analysis.
- Applying formalized actions (**NFF Procedures**) can help reduce repeat failures and standardize investigation techniques which can then be optimized as necessary.
- NFFs can be intermittent technical faults. Any known intermittent faults are usually responsible for a proportion of NFF defects. If this is suspected, it should be considered when establishing priorities.
- Some NFF defects can be identified by repetitive testing (Door Faults).
- Some NFF defects can be mitigated by improved maintenance (Limit switch settings / over-travel).
- Intermittent faults on electrical components may be highly intermittent (repeat faults may become apparent from serial number comparison).
- Analysis of Fleet NFF Trends can be used to measure improvements separately from the main reliability failures database or on a unique row for each category in the same database.

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## Section 2 - 2 Identify Root Causes Continued (Non Technical Faults)

- Non Technical Faults can be a significant part of a fleets reliability statistic.
- The IDU filter will no doubt reduce the number of incidents when implemented.
- It is important to involve Operations in War Room activities to help reduce this element of failures.
- Operations should be encouraged to control this work stream to ensure it is not overlooked.
- Operations can take on tasks to ensure all relevant operations staff are made aware of actions necessary to reduce numbers of non technical faults .
- Potential Improvements / Actions include:-
  - Drivers briefings
  - Driver training
  - Drivers fault finding procedures
  - Advice given to drivers at time of fault
  - Further changes to IDU filtering

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## Section 2 - 3 Process Fault Data and Prioritize

- This is only truly effective once the root cause is known and data separated accordingly in the database.
- The database should capture impact of each root cause, for example the number of incidents and or delay caused.
- The data should be entered into a matrix which records the impact of failures in intervals of time. This will allow trend analysis of the data to evaluate if the rate of failures is increasing.
- The database should contain columns to prompt the user to consider some typical RCM (Reliability Centred Maintenance) questions, for example:-
  - Is the failure rate increasing? If a failure rate is increasing significantly, addressing this failure may be more critical to future reliability than random failures which currently have a greater impact.

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## Section 2 - 3 Process Fault Data and Prioritize Continued

- Is the failure safety related? If the answer to this question is yes, the failure needs to be risk assessed to ensure that safety concerns are addressed accordingly. These failures are likely to be a higher priority than all other purely reliability failures. This should be identified in the database and all reports derived from its contents.
- Can the failure be predicted? If the answer to this question is yes because the degradation or wear is visible and can be seen or evaluated by a simple test, it may be more appropriate to carry out a maintenance mitigation either as a short term fix or permanent rectification.
- Is the component relevant to the root cause covered by heavy or light maintenance? It may emerge that maintenance needs to be changed to mitigate the failure.
- It may prove necessary to implement a campaign check ahead of maintenance regime alteration to achieve a more immediate benefit.
- Training regimes can incorporate improvements and stress key areas to be covered in maintenance. Operator and or Maintenance briefings can be implemented to achieve a more immediate benefit.

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## Section 2 - 3 Process Fault Data and Prioritize Continued

- To apply RCM techniques to a complete train fleet can be a costly and time consuming task, however, to train key personnel on the principles involved and encourage these to be applied to key areas of the train and its maintenance would be beneficial. It encourages staff to consider the most appropriate means of mitigating failures which is not always a modification. (A conclusion which engineering staff are most likely to select).
- For some failures particularly those with safety related consequences, potential incidents or near misses are important to record. For example, a wrong side brake or door failure which did not necessarily cause a casualty, but could have caused a major safety related incident under different circumstances.
- As soon as practically possible, the failures database should incorporate and estimate the cost arising from each root cause. This element is important for comparison with the cost of potential fixes for root causes, particularly as the reliability of the trains increases and train reliability reaches its potential. As this point in time approaches, reliability improvements will become more difficult to justify.

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## Section 2 - 3 Process Fault Data and Prioritize Continued

- An important part of processing the data is predicting future reliability.
  - There are many ways to achieve this goal. All are estimates which subject to error.
  - To minimise error it is considered best to apply predictions to each root cause mitigation separately.
  - It is important to identify if the rate of failure is static, or changing over time and apply the anticipated prediction changes to these figures.
  - The periodic fleet reliability equates to the sum of all root causes impacts and other periodic failures impacts. The net change in fleet reliability can be forecast from these periodic totals.

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## Section 2 - Simplified Failure Database Used To Generate Prediction

All this example is attempting to show is one means of creating a future prediction in failure rates / or impact by estimating the impact of improvements on future failure rates.

In this hypothetical table, RC1 and 2 are root causes for which the past failure rate suggests the failure rate is random and there is no plan to apply any mitigation. Future failures are predicted to be the average periodic rate.

Mod A mitigates failures to root cause 3 (RC3) and is predicted to eradicate all failures.

Mod B mitigates failures to RC4 and is estimated to halve the failure rate.

RC5, 6 and 7 are unmitigated and their failure rate trends are predicted.

| | | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 |
|---|---|---|---|---|---|---|---|---|---|
| Mod A | RC3 | 100% reducion | | | | START | | FINISH | |
| Mod B | RC4 | 50% reduction | | | | | START | | FINISH |
| Failures | Root Causes | PAST | PAST | PAST | Future | Future | Future | Future | Future |
| A | RC1 | 2 | 3 | 2 | 2.3 | 2.3 | 2.3 | 2.3 | 2.3 |
| B | RC2 | 2 | 4 | 3 | 3 | 3 | 3 | 3 | 3 |
| C | RC3 | 7 | 5 | 6 | 6 | 5 | 3 | 1 | 0 |
| D | RC4 | 6 | 7 | 6 | 6.3 | 6.3 | 5.8 | 4.8 | 3.8 |
| E | RC5 | 1 | 2 | 1 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 |
| F | RC6 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| G | RC7 | 6 | 5 | 5 | 5.3 | 5.3 | 5.3 | 5.3 | 5.3 |
| H | ? | 9 | 1 | 0 | | | | | |
| I | ? | | | | | | | | |
| TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL |
| k | ? | | | | | | | | |
| TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL | TOTAL |

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## Section 2 - 4 Identify Potential Modifications / Improvements

- If the previous step has shown that there may be alternative means of mitigating the root cause, all alternatives need to be considered. These could be:-
  - Redesign
  - Minor modification
  - Change routine maintenance (Scope, periodicity or replace item routinely or on condition).
  - Change heavy maintenance (Scope, periodicity, overhaul or replace item routinely or on condition).
  - Change maintenance practice over a set period of time each year to address seasonal failures. (For example frost or leaf fall).
  - Combination of above.
  - Mitigate though operation (Live with the issue but mitigate the impact of the failure by changing how failures are dealt with).
  - Do nothing (Temporarily or indefinitely).

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## Section 2 - 4 Identify Potential Modifications / Improvements

- The cost of each rectification should be compared with the cost emanating from the root cause and the perceived saving each alternative offers.
- Increase in failure rate for some items will clarify the need for heavy maintenance is impending.
- If preventative maintenance / test is impractical then modification or change may be the only corrective solution.
- If failure cannot be prevented, it still may be possible to mitigate the impact of failure by implementing mitigations to be applied upon failure occurrence. e.g. actions to be taken by Operations / Out-based support staff.
- Do Nothing - Some root causes and their respective potential improvement will emerge as a low priority, (low perceived impact / potential saving). It may be more prudent to deal with higher priorities first. Some failures may never prove cost effective to deal with or only cost effective as part of an overhaul cycle. Gathering the costs for each root cause is important to enable this decision process to be made effectively. The failure rates of these root causes should continue to be monitored as they may become a higher priority / cost effective to deal with in the future.

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## Section 2 - 5 Justify and Seek Authority for Optimum Improvement

- All modifications must undergo risk assessment scrutiny / authority to proceed before implementation. Experience with generating risk assessments / justifications will help speed up this process.
- Maintenance improvements to mitigate potential failure may prove quicker to implement.
- Some improvements may prove viable for implementation at overhaul / justify early overhaul.
- Improvements to totally eradicate failure may be impractical. Realistic reductions in failure rates should be predicted.
- Potential costs savings from reduction of failures may help justify the implementation of changes financially.
- The optimum improvement may well prove to be the change which quickly produces the largest saving for the least investment.
- In the future as it becomes increasingly difficult to implement cost effective improvements, the units may be considered to be reaching their level of inherent reliability.

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## Section 2 - 6 Implement Improvement

- Improvements may be a change to the maintenance regime, material / quality improvement, campaign check, maintenance briefing, operator briefing or modification.
- The start and completion dates for any planned improvement together with the anticipated benefit are an important input into War Room discussions. These details will feed into reliability predictions.
- Progress of the implementation against target completion dates should be discussed at each War Room meeting until complete.

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## Section 2 - 7 Monitor Benefit Improvement

- Anticipated benefits of improvements may be input into the reliability spreadsheet over future periods to generate a prediction in change of total unit reliability as previously shown.
- As actual figures are inserted into the spreadsheet, it will become apparent if each improvement implemented is producing the desired reduction in failures.
- The improvement attained in relation to predicted improvements should be discussed in the War Room. It may emerge that the modification or mitigating action implemented is not having the desired effect and more work is necessary.

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SECTION 3

# IMPLEMENTATION PLAN

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# Section 3 - Implementation Plan

The information sources for reliability improvement are currently in place. The Project Team, Depot Drift Team and Operations organisations are also in place. The principle missing resources need to be implemented as follows:-

- RIT Additional Staffing
  - The additional staff required to identify root causes and process the data into root causes can be integrated into the team as soon as they become available. Both tasks are of equal importance and should be implemented as soon as possible. The first two additional staff recruited should cover both of these activities.
- The RIT urgently require additional staff to identify root causes and process the data emerging into root cause categories. Both tasks are of equal importance and therefore the first two additional staff recruited should be assigned cover both of these activities. A further 3 staff will be needed to fully define root causes and work with the Depot Drift team to improve reliability. A further 2 staff will be required to process the information from DTO, analyse the information and produce predictions against targets set. It would be appropriate for an additional person to ensure that reliability improvements are adequately achieved in maintenance plans, documentation and training.
- This level of staffing is required to overcome the current volume of faults and their rectification. As the reliability of the fleet increases and the number of new / unresolved issues decreases, the numbers of RIT staff required will decrease to a core team. It is recommended that staffing is revaluated periodically to adjust the numbers to the emerging workload.

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# Section 3 - Implementation Plan Continued

- An overview of the RIT team is shown below:-

| | |
|---|---|
| – Team Leader | 1 |
| – Technical Support and Root Cause Investigation | 3 |
| – Data Processing and Analysis | 2 |
| – DTO | 1 |
| – Prediction and target-setting | 1 |
| | 8 total |

- Separation of Failures into Root Causes
  - This will be an ongoing task throughout the life of the unit. This is not currently in place and will require a significant effort to separate current data into all known root causes. As time progresses the number of emerging root causes emerging will decrease exponentially. Small increases may occur following future overhaul of components which can sometimes produce new failures.

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## Section 3 - Implementation Plan Continued

- War Room Initialisation
  - The War Room concept may be unfamiliar to existing staff. It is important that all parties agree to participate and support the War Room activities. It is therefore important that this support is obtained from higher levels of management within each contributing team. A kick off meeting supported by management of each organisation may be the best means of achieving this and removing obstacles which may arise.
- War Room Layout
  - Typically war rooms do not have tables and chairs to encourage discussions to be brief and to the point. Available wall space is used to record action holders action due dates, targets and progress towards achieving each target. The presentation of data can be written by hand onto appropriately sectioned white boards around the walled area. War rooms walls can be covered with video display units, however, this is not recommended particularly for the early stages of development.
  - Effective use of colours within the war room displays can be used to identify key issues or problems at a glance. For example red can be used to display failures to achieve targets or delays.

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## Section 3 - Implementation Plan Continued

- Output from War Room
  - Emerging Actions - Reliability improvement actions emerging from the war room can sometimes clash with other activities. Individuals involved with the war room and taking away actions from it may have other priorities set by their respective management teams. If these external priorities continually delay war room actions from completion, higher management can be invited to the war room to resolve such issues.
  - Shifting Priorities - Care should be taken to use data from as large a time frame as possible to dictate priorities. Basing priorities on small periodic inputs of data (particularly during early stages of RIT implementation) can lead to erratic changes in quantities of casualties and therefore priorities emerging. This can be detrimental to long term reliability improvement.
  - Customer Interface - DSB will have a number of internal customers who are interested in increasing the reliability / performance of the fleet. These customers can be invited along to periodic war room discussions to show them how issues are being dealt with and enable them to make comment. This should be encouraged as it aids understanding from all parties and will reduce the number of progress reports these customers may require for information. Ideally these attendees should be encouraged to attend and be given the chance to input at the end of war room discussions. Too many inputs into War Room discussions can be detrimental.

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