

Transitioning from TickIT to TickIT*plus* at the National Physical Laboratory

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Abstract

In November 2014, the National Physical Laboratory successfully transitioned to the new TickIT*plus* software quality certification from the predecessor TickIT certification. This Management Study summarises the steps required to achieve transition. It also discusses NPL's reasons for requiring certification of those parts of its Quality Management System that concern software development. What is the justification for the effort and expense?

The authors include a brief description of how software quality management is implemented within NPL.

Although transition is no longer possible, our experiences may prove useful to organisations considering TickIT*plus* certification.

Keywords: Software, Quality, Certification, TickIT*plus*, NPL.

1.0 Introduction

The TickIT scheme [1] ensured competence in the certification of ISO 9001 certified organisations whose Quality Management System contained procedures for software development. Certification bodies offering TickIT would provide IT specialist assessors to audit the quality management of software development. The National Physical Laboratory had held TickIT certification ever since it achieved ISO 9001 certification in 1996.

TickIT*plus* [2, 3], which superseded TickIT in 2014, has a wider scope. It was developed and is maintained by the Joint TickIT Industry Steering Committee (JTISC) of the BSI [4]. The aim was to address two main issues:

- IT activities other than software development have now become essential to the operation of many organisations, e.g. IT Service Management. Audits by IT specialist assessors of these activities will add value to an organisation's certification.
- A requirement for graded levels of capability, analogous to the levels offered by Capability Maturity Model Integration [5], to allow detailed comparison between suppliers. For certified organisations they provide a path to higher levels of certification.

Therefore, TickIT*plus* includes options (called 'Scope Profiles') for certification of Information Management and Security, IT Systems Engineering & Infrastructure and IT Service Management, as well as software development. TickIT*plus* defines five rising levels of certification from Foundation and Bronze to Silver, Gold and Platinum. Organisations are certified through capability assessments.

In this management study we describe how the transition from TickIT to TickIT*plus* was achieved.

1.1 The Transition Period

For a limited period, while TickIT was being withdrawn and TickIT*plus* introduced, organisations with TickIT certification were given the option of transitioning to TickIT*plus* Foundation level certification through their certification body.

Certification from first principles would have required detailed auditing of the software quality management system. Transition assumed that the software quality management system was sound and concentrated on mapping this system to a TickIT*plus* Process Reference Model (PRM, described in section 3.4.1).

2.0 The National Physical Laboratory

The National Physical Laboratory is the UK's National Measurement Institute, and is a world-leading centre of excellence in developing and applying the most accurate measurement standards available [6]. It employs approximately 800 staff.

NPL has made many contributions to modern-day computing [7, 8]. To this day mathematicians and computer scientists provide vital support to NPL [9].

2.1 Software Quality Management at NPL

Quality management of the development and procurement of software is an essential part of NPL's ISO 9001 certified Quality Management System [10]. Much of the software is developed in-house by NPL's staff. Commercial off-the-shelf packages are also used, along with software developed by third party contractors.

Despite producing some software products, available either free of charge or at a cost [9], outside distribution of software is not a core NPL activity. However, development and use of software lies at the heart of much of NPL's work. Software is used to control experiments and apply mathematical algorithms to data produced by these experiments. The days of someone sitting in front of a wobbling needle, noting down numbers on a piece of paper, are gone.

Databases and spreadsheets are also considered to be software as much as, for example, C++ or .NET programs. Therefore the work of finance, administrative and support staff is included within the software development aspects of the Quality Management System. An accountant developing a spreadsheet can be considered as much of a software developer as a scientist or mathematician processing the results of an experiment [11].

2.1.1 The Challenge

An approach to software quality management perceived as excessively bureaucratic and liable to stifle innovation will not succeed within a community of independently-minded scientists. Also it should not appear too onerous to those who may not necessarily consider themselves software developers.

The attitude the Corporate Assurance Team promotes is that quality aspects of software development should not be thought of as optional overheads. They should be about sensible good practice that makes software development easier. Ultimately, what needs to be achieved can be summarised into the following areas:

- *Traceability*

If someone requires confirmation of how a number was calculated, the means of calculation must be readily available (e.g. the correct version of

any source code / spreadsheet / database and documentation). Any input or output files must also be available. This principle applies whether the number is a calibration value quoted on a certificate or the amount of a project budget spent over a particular period of time.

- *Transferability*

If the original developer or user of a piece of software / spreadsheet / database hands it over to someone else, it needs to be easy to explain how it works and to prove that it works. Handover must also be possible even if the original developer is no longer available.

- *Maintenance*

Understanding how documented code works is easier than trying to understand undocumented code. As stated above, the correct version of any source code etc. must be readily available. Other information required to modify the software (e.g. enhancement requests or bug fixes) must also be easy to obtain. All of the above must be obtainable without having to consult the original developer(s), who may be unavailable.

Examples of typical situations to be considered include:

- The PC used to run a particular piece of software needs to be replaced. The software works well and there is no reason for it to be rewritten. The correct version of the source code must be obtainable easily so it can be ported to a new PC.
- Today's 'proof of concept' could be tomorrow's customer service. This should always be taken into account when developing software for experimental purposes.

2.1.2 Flexibility

A flexible approach is required. Flexibility does not mean compromising on being thorough. Requirements capture is a good example. For some software (e.g. a system that will control an experiment, process data and generate values to be displayed on calibration certificates) requirements documentation containing an appropriate level of detail needs to be written. A review of this documentation by the project team, with perhaps mathematics independently verified by a mathematician, will be required. For other projects (e.g. a system to help automate a simple, but repetitive, administration task) a simple list of bullet points, checked by a manager, will be sufficient.

Code documentation is another example. NPL's Quality Management System requires code to be adequately documented. Sometimes adequate documentation can simply mean thorough comments throughout the code.

2.1.3 Risk Analysis

The starting point for all such projects, whether administrative or scientific, is a risk analysis from which a software quality plan is generated. Factors such as criticality of usage and the complexity of the software / spreadsheet / database are reviewed to determine how best to implement the software quality requirements.

3.0 Achieving Transition

Transitioning to TickIT*plus* can be summarised in the following steps, each of which are described in this section:

- Decide whether to go ahead. Although developing software is a key day to day activity at NPL, would obtaining such certification be worthwhile? Could the effort and expense be justified?
- Having decided to go ahead, make a profile selection from the TickIT*plus* Base Process Library [12]. Should the focus remain solely on software development or should other aspects of TickIT*plus* certification, e.g. the Scope Profile for IT Service Management be included?
- Develop the NPL TickIT*plus* Assessment Strategy and map software quality management procedures to the selected TickIT*plus* Base Processes according to the Scope Profile. Carry out gap analysis and prepare the Process Reference Model.
- Carry out a readiness review with the external certification body (Stage 1) in preparation for the transition assessment (Stage 2).

3.1 Decision to Proceed

The time, and therefore expense, required by NPL's Corporate Assurance Team was anticipated as being significant. One person-month was estimated for project management and development of the mandatory scheme documentation. External assessors would audit developers' work directly, in addition to the internal audits required by ISO 9001. These audits would require further expense in terms of staff time. The charges of the certification body itself also needed to be taken into consideration.

After TickIT was discontinued why not hold ISO 9001 certification only? Alternatively, why not consider another scheme, such as Capability Maturity Model Integration?

The Corporate Assurance Team decided to recommend TickIT*plus* to NPL's Management Executive Team. Reasons for recommendation included:

- As the UK's National Measurement Institute [6], NPL is strongly committed to third party certification of its management systems. TickIT*plus* underlines NPL's commitment to excellence in software quality management.

- TickIT*plus* provides a mechanism and vocabulary whereby project managers and senior management, who aren't necessarily programmers or indeed technical, can satisfy themselves that what is being produced conforms to an accepted common assurance structure.
- TickIT*plus* provides a system auditing mechanism that doesn't necessarily rely on the audit being undertaken by an ex-programmer. This system satisfies two conditions: firstly the assurance structure isn't open to the whim of an assessor who could re-write the code through raising non-conformities. Secondly, the audit terminology allows easy comparison between audited areas and facilitates lessons-learned and improvement in a classic ISO 9001 sense.
- The TickIT*plus* maturity model fits well with ISO 9001, which is embedded in NPL's systems, and is an existing fit with NPL's software programming assurance structure.
- The maturity model means that NPL can start small and grow, if required. The baseline processes can be sufficient to support a registered assurance system.
- Capability Maturity Model Integration (CMMI) is not ISO-based, which is not a good fit with a National Measurement Institute promoting standardisation of processes.
- As already stated, 'programming' includes development of spreadsheets and databases, Once again the terminology used encourages those not employed full-time writing software, to follow the same assurance conventions.

A business case detailing the scope of work required for the transition project was prepared and submitted to the Management Executive Team in June 2014. Authorisation to proceed was granted and resources allocated to the project with a target to complete the transition and obtain certification by the end of November 2014.

The certification body confirmed that the transition assessment would consist of two stages, totalling 5 person-days, with Stage 1 being a 2-day visit and Stage 2 being a 3-day visit.

3.2 Select Scope Profile

The *Systems and Software Development and Support* Scope Profile was chosen for transition. At this stage, inclusion of additional Scope Profiles was not considered since TickIT*plus* was required to support software development.

3.2.1 Further Profiles

After transition, a decision needed to be made whether to adopt other applicable Scope Profiles, e.g. *Information Management and Security* and *IT Systems Engineering and Infrastructure*.

Clearly, certifying all of the above activities through a single scheme has many advantages. Working with one certification body and assessor team has to be far most efficient and cost-effective than multiple bodies and teams.

However, other schemes, such as the UK Government-backed Cyber Essentials [13] may be more widely recognised by NPL's customers for IT activities other than software development.

Customer recognition is one of the main reasons certification schemes exist and key to deciding which scheme to adopt. Other schemes may offer even wider recognition, the Corporate Assurance Team is investigating various options. It is anticipated that for the foreseeable future NPL's TickIT*plus* certification will remain focused on software development. This situation will be reviewed regularly as part of continual improvement.

3.3 Assessment Strategy

An Assessment Strategy document was written as defined by the TickIT*plus* Core Scheme Requirements [14] and includes the software development approach at NPL, details of existing ISO 9001 certification and UKAS accreditations, the organisational and TickIT*plus* scope and the approach to process improvements. The Assessment Strategy is reviewed annually during the Corporate Management Systems Review and is authorised by the NPL Quality Manager.

3.4 Mapping NPL Procedures to TickIT*plus* Processes

The requirements for TickIT*plus* certification are defined in terms of a Base Process Library. Processes are grouped by type: Organisational, Project and Technical.

The *Systems and Software Development and Support* Scope Profile defines 22 Base Processes. Examples of the various types of process include:

- ORG.1 Human Resource Management
- ORG.5 Improvement
- PRJ.1 Project Management
- PRJ.3 Configuration and Change Management
- TEC.4 Verification
- TEC.13 Architectural Design

3.4.1 Process Reference Model

A TickIT*plus* Base Process consists of a number of *Base Practices*. Each Base Practice maps input work products to output work products by referencing quality system procedures. The Base Practice also cross references clauses from ISO standards where applicable.

A Process Reference Model (PRM) was compiled which maps the existing NPL corporate and software quality management procedures to the Base Processes for the Scope Profile. An example of such mapping is shown in the table below:

Base Process: PRJ.3 – Configuration and Change Management	
<p>Process Outcome: OU.1 The Version and relationship of all work products are known at all times.</p>	<p>Process Purpose: To manage and control the work products required to maintain the integrity of the product.</p>
<p>Base Practice.4 Manage Configuration Items: Configuration items are uniquely identified, managed and tracked to ensure that the latest status information is recorded and the item is available.</p> <p>NPL Procedures: Configuration Management: QPNPL/M/005 IT Change Management: QPNPL/M/014</p> <p>ISO 9001:2008 Clause: 7.5.3</p>	
<p>Input Work Products: Configuration Items</p>	<p>Output Work Products: Configuration Items</p>

Table 1. Example of mapping NPL Procedures to Base Practices

3.4.2 Gap Analysis

Where gaps in procedures and improvement opportunities were found, tasks were added to an improvement plan and actions progressed to closure through weekly meetings. Improvement opportunities included:

- Procedure “NPL Project Framework Core Requirements” reviewed to ensure that there is adequate governance for projects containing a software development element, including spreadsheets and databases.
- Procedure “Guidelines for Source Code Review” updated to include graphical programming languages.
- Updates to the corporate NPL-Written Software procedure to promote use of web-based bug reporting tools.

3.5 Awareness

To promote awareness of the TickIT*plus* transition activities across NPL, a briefing was arranged and attended by senior stakeholders and software developers across many areas of the business. The briefing was presented by Dave Wynn, author of

the TickITplus Core Scheme Requirements and JTISC Working Group Member. With NPL being an early adopter of the TickITplus scheme, the briefing was invaluable to the authors and all delegates.

Awareness of the TickITplus scheme is also promoted through dedicated software quality pages on the NPL intranet and by induction presentations to new starters across all areas of the business.

3.6 Assessment

TickITplus requires that either external assessors examine projects for evidence of compliance (Exploration Mode) or staff from the organisation under audit be trained and registered as TickITplus practitioners [15]. Practitioners provide external assessors with evidence of compliance (Confirmation Mode).

The deadline for transition did not allow sufficient time for NPL staff to be trained as practitioners. Therefore to achieve transition, the external assessors would review software development projects directly in Exploration Mode.

Stage 1 of the assessment commenced on 5th September 2014 with an examination of the Assessment Strategy, Process Reference Model and evidence of internal software quality audits carried out by the Corporate Assurance Team. The certification body assessor verified that the necessary documentation was in place and confirmed NPL's readiness for Stage 2.

Stage 2 commenced on 22nd September 2014 with an examination of a variety of software development projects. These projects included:

Project Name	Description	Reference
MTDATA	Tool for calculation of thermodynamic properties. Used both within NPL and available externally.	[9]
TraCIM Computational Aims Database	A web-enabled database developed as part of the EU-funded Traceability for Computationally-Intensive Metrology (TraCIM) project.	[16]
XLGENLINE	Calculates best-fit low degree polynomial calibration function to a set of measurement data. A version of XLGENLINE used internally within NPL was examined.	

Table 2. Examples of software projects reviewed during transition

Using the Process Reference Model, the assessor examined each project and witnessed evidence of compliance for each of the Project and Technical Base

Processes. To satisfy compliance with the Organisational Base Processes, evidence was collected through a series of interviews with members of NPL's Human Resources, Information Technology, Project Management and Corporate Assurance Teams.

Stage 2 concluded on 17th October 2014 with a recommendation by the certification body for transition to *TickITplus*. NPL received certification to Foundation level on 27th November 2014. As part of continual improvement, NPL's Corporate Assurance Team are reviewing the requirements for upgrading to Bronze.

4.0 Final Thoughts

NPL is committed to *TickITplus* as a means of ensuring best practice in quality management of software development. For reasons described in section 3.2.1, *TickITplus* certification at NPL will remain focussed on software development for the time being.

Subsequent to transition, NPL has decided to continue with external assessors examining projects for evidence of compliance. This approach fits in well with our other accreditations and certifications [10] which require regular visits from external registration bodies such as UKAS [17].

Ideally everyone involved in an audit, management and assessors as well as auditees, should approach it in the right spirit. A friendly expert casting an independent eye over a project can be interesting and informative. Sometimes it can even, dare we say, be enjoyable.

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