

ICT Testing

1. Statement

The purpose of the ICT Testing Guideline is to:

- Support and enable successful implementation of the ICT Testing Policy.
- Define the broad objectives of ICT testing and set out general guidelines to support meeting these objectives.
- Define general testing roles, processes and techniques to support meeting test objectives.
- Establish a guiding framework to support test planning, implementation and reporting.

This document has been developed at a high level and is designed to be applicable across all development methodologies used within Queensland Health (e.g. waterfall, agile, dev-ops etc.).

This document describes required roles and activities at the project level within a project lifecycle. Where no specific reference is made, any description for project level should be considered equally applicable to changes where a project is not formally involved (e.g. for operational changes managed under a service management lifecycle).

2. Scope

Compliance with this guideline is not mandatory, but sound reasoning should exist for departing from the recommended principles within a guideline.

This guideline applies to all test activities undertaken for ICT changes.

3. Requirements

3.1 Objectives of testing

As stated in the ICT Testing Policy “*ICT testing contributes to improving quality outcomes over the full asset lifecycle of ICT*”.

Quality outcomes are at risk whenever new or changed ICT products and/or services are implemented. In particular there may be underlying risks that business operations will be negatively impacted by:

- the quality of the product delivered (i.e. the product may have defects), or
- the suitability of the product delivered (i.e. the product may not meet requirements that have been specified by customers).

The primary objective of testing then is: *to reduce the likelihood of Queensland Health business operations being negatively impacted by the implementation of new or changed ICT products and/or services.*

3.2 Risk management

In accordance with requirement 5.3 of the ICT Testing Policy, risk-based testing should occur where appropriate as part of the overall approach to ICT testing.

In accordance with requirement 5.6 of the ICT Testing Policy, wherever risk based testing occurs test work products (e.g. test plans, test cases and test reports) should document traceability to risks covered by testing.

It is expected that testing may uncover new risks that will need to be reported. In accordance with requirement 5.6 of the ICT Testing Policy, all reporting of risks should be conducted in accordance with the Department of Health risk management framework.

3.3 Health Software

It is important from a testing perspective to distinguish between ICT products and/or services which impact patient care and those that do not.

For the purposes of this guideline, ICT products and/or services will be considered to be 'health software' where they meet the following definition:

Health software - *Software used in the health sector that can have an impact on the health and healthcare of a subject of care.*¹

A determination about whether an ICT product and/or service is considered to be 'health software' or not should be made by the responsible information asset custodian.

3.4 ICT safety in health software

Testing should form part of the overall quality management approach for all ICT products and/or services (including health software). General guidance on appropriate testing for improving quality (thereby improving safety) is implicit in the guidance provided throughout this document.

In particular, where testing is required for ICT products and/or services involving health software, an appropriate level of engagement and consultation should occur with clinical stakeholders. The appropriate level of engagement and consultation should be defined in the relevant Test Strategy and agreed with all stakeholders.

In addition, improving safety in health software can be supported by consulting applicable best practice standards.

3.5 Test selection and prioritisation

In alignment with best practice testing standards, selecting and prioritising tests for execution should occur wherever possible.

In such cases a prioritisation procedure should be documented in test plans taking into account contextual attributes in accordance with requirement 5.3 of the ICT Testing Policy.

For example:

- Where risk-based testing is implemented, test cases (or sets of test cases) designed to cover specific product risks are assigned a priority in agreement with the implicit hierarchy of the initial risk ratings defined on the relevant risk register. (i.e. Test cases designed to cover risks with a higher risk rating should receive a higher priority)
- Where specification-based testing is implemented test cases (or sets of test cases) designed to cover specific requirements are assigned a priority in agreement with the priority assigned in the source requirement document. (e.g. Test cases designed to cover 'mandatory' requirements should receive a higher priority)

3.6 Testing documentation

In consideration of requirement 5.3 of the ICT Testing Policy the level of formality in test documentation should be context appropriate.

In general, testing documentation should be comprised of the following²:

For the overall project or service lifecycle:

- A high level test planning and test management guide. (i.e. A test strategy or master test plan)

For a specific ICT change:

- A test plan (i.e. test objective, detailed approach, schedule)

¹ As defined in ISO/TR 17791:2013 - Health informatics – guidance on standards for enabling safety in health software

² These documents may be consolidated into one or more documents, as appropriate, depending on the context.

- Test specification(s) (i.e. nominated test cases for execution)
- Test results (i.e. actual results of executed test cases)
- Test report(s) (i.e. reporting and analysis of results in terms of test objective)

Staff responsible for implementation of the ICT Testing Policy are recommended to consult the Department of Health ICT testing templates and guides for documentation guidance. These templates and guides have been tailored for the department and are based on international standard ISO/IEC/IEEE 29119-1:2013E Software Testing.

Current versions of templates and guides can be accessed from the ICT Testing Service intranet site. (<http://qheps.health.qld.gov.au/icttesting>).

In accordance with requirement 5.4 of the ICT Testing Policy, testing documentation should be communicated to interested stakeholders in a timely manner.

In accordance with requirement 5.8 of the ICT Testing Policy, testing documentation should be organised and stored in an appropriate archive for future reference.

3.7 Configuration management of test work products

In alignment with best practice testing standards, the work products related to testing (e.g. risk registers, requirements documents, test plans, test reports etc.) should be managed under an appropriate configuration management process.

The configuration management process should ensure that:

- Work products are assigned a unique identifier each time they undergo change
- A record of changes to work products is maintained and available for review

Configuration management information for work products should appear on all testing documentation where work products are referenced.

3.8 Defect management

In alignment with best practice testing standards, for a project or service lifecycle a defect management procedure should be defined (either as part of the test strategy/master test plan or as a separate document).

Alternatively the existing eHealth Queensland Defect Management Procedure may be adopted and referenced or adapted. (Defect Management Procedure ID01068)

The defect management procedure should describe an approach to:

- Raising and reporting defects
- Analysis and triage processes
- Severity and priority classification
- Maintenance of traceability between defects, test cases and test coverage objectives
- Defect status states (from creation through to closure)
- Recording root cause information to inform process improvement
- Maintaining auditability.

In accordance with requirement 5.8 of the ICT Testing Policy defect information should be retained and available for audit purposes.

3.9 Retesting and regression testing

In alignment with best practice testing standards, test planning should anticipate and accommodate additional testing that may become necessary as the testing phase progresses. For example:

- retesting after defects have been fixed, and
- regression testing to reconfirm areas previously tested after change has occurred.

3.10 Testing roles and responsibilities

In accordance with requirement 5.3 of the ICT Testing Policy the following testing roles should be appropriately resourced and supported by training based on the context of the testing. These roles may not directly align to positions however testing roles and responsibilities should be appropriately assigned to team members conducting test activities.

Role	Responsibilities
Test Manager	<ul style="list-style-type: none"> Leads and manages the testing Manages testing resources Manages reporting Develops test documentation Ensures adequate training in testing techniques and tools Allocates Defect Triage Resource(s) Manages test process improvement Configuration management of test work products
Test Lead	<ul style="list-style-type: none"> Leads a small team of test analysts/testers Reports progress to test manager Mentoring/coaching of test analysts/testers Implements test process improvement Configuration management of test work products
Test Analyst	<ul style="list-style-type: none"> Analyses test basis (i.e. Risks and requirements) Identifies test conditions Designs test plans and test cases to achieve test coverage Executes the tests Records results Assists developer with defect resolution Assists with developing test documentation Configuration management of test work products
Tester	<ul style="list-style-type: none"> Executes the tests Records results Assists developer with defect resolution Configuration management of test work products
Test Automation Consultant	<ul style="list-style-type: none"> Develops and maintains test automation scripts and test data Communicates test automation results to test manager Configuration management of automation environment
Test Environment Manager	<ul style="list-style-type: none"> Manages test data and test environment Maintain and refresh test databases Assists with construction of test data Build test databases and environments as required Configuration management of test environment
Test Assurance Consultant	<ul style="list-style-type: none"> Provides independent detailed review feedback and assurance functions on prescribed test work products. Services may be engaged via the eHealth Queensland ICT Service Catalogue or through an external provider

3.11 Tester education

In support of the ICT Testing Policy, specific testing skills required for individual positions for which testing is an expectation should be captured in the related position description. Resources occupying roles described in section 3.10 – Roles and Responsibilities should have received appropriate training.

Formal training can be sourced from external providers. In addition the following services are offered within eHealth Queensland:

- Test practice management is available as a service in the eHealth Queensland ICT Service Catalogue. Expert advice and guidance is provided to resources occupying testing related roles.
- Test assurance is available as a service in the eHealth Queensland ICT Service Catalogue. The test assurance review process can assist resources participating in testing by providing feedback which includes improvement suggestions aimed at educating testers.
- Self-paced learning is facilitated by the documents available on the ICT Testing Service intranet site.

3.12 Tester independence

In alignment with best practice testing standards, the independence of those planning and performing the testing from those designing and developing the ICT product and/or service should be considered as a factor contributing to improved testing outcomes.

Where possible tester independence should be a goal considered within the contextual attributes considered in accordance with requirement 5.3 of the ICT Testing Policy.

3.13 Test levels and techniques

3.13.1 Test levels (phases)

In alignment with best practice testing standards, it is expected that testing for complex releases will be broken into distinct phases or 'Test Levels' (e.g. unit testing, component testing, integration testing, system testing, acceptance testing).

Anticipated test levels should be identified during test planning.

For each distinct test level identified in a test planning document an appropriate level of detailed planning should occur. (E.g. Level-specific scope, objective, test criteria, test environment, documentation and reporting requirements, test design techniques etc.)

3.13.2 Test Design Techniques

Guidance on test analysis and design techniques should be included as part of test planning. Appropriate techniques should be selected based on the testing context and objectives of the overall test approach.

The following are examples of techniques that may be commonly applied:

Specification-based techniques:

- Positive and negative testing of functional requirements
- Boundary value and equivalence partition testing of data (e.g. dates, lookups, business rules)
- Scenario testing
- Random testing

Experience-based techniques

- Error guessing
- Exploratory testing

Structure-based techniques

- Statement testing
- Branch testing

- Branch condition testing
- Data flow testing

3.13.3 Traceability and Test coverage

In accordance with requirements 5.5 and 5.6 of the ICT Testing Policy, tracing coverage of requirements and risks (from test plans to test cases through to test reports) should occur for all testing where specification based techniques are used. In such cases coverage should be clearly aligned to the test objectives.

Test coverage relevant to test design techniques should also be reported where the information is relevant to the test objectives. (For example, where 'random testing' is used as a technique, coverage might be reported as: "120 random records were selected for testing from the test dataset of 12000 records, representing a 1% sample size")

Test coverage of test environment configurations should also be reported where the information is relevant to the test objectives. (For example, for a web application coverage might be reported as "All test cases were executed using Firefox 20 and Internet Explorer 10. Other browsers were not tested.")

3.14 Test criteria

In alignment with best practice testing standards, a variety of criteria should be used to manage testing. For example, to decide when testing is ready to start (entry criteria), must suspend or can resume (suspension and resumption criteria), or is complete (exit criteria or completion criteria).

These criteria should be specific, measurable and should be recorded in the test planning documentation (i.e. the test strategy/master test plan and/or the test plan).

Test criteria should align to the objectives of testing as defined in the relevant planning document.

3.15 Test process improvement

In accordance with requirement 5.7 of the ICT Testing Policy, test process improvement is a fundamental testing requirement and is the responsibility of the test manager.

After each deployment time should be allocated to reflect on lessons learned with a view to the implementation of improvement options for testing of future deployments.

Metrics should be collected to inform test process improvement. In addition the value of testing should be monitored to measure the success of improvement initiatives.

3.15.1 Sources of Improvement Information

The following processes and procedures may provide a potential source of test improvement information (e.g. metrics, feedback etc.):

- Test assurance review processes provide improvement suggestions and key findings which are intended to facilitate test improvement.
- Post Implementation Reviews (PIRs) conducted after failed deployments. Findings in a PIR may contain test improvement recommendations.
- Retrospectives held after agile iterations are intended to identify actions for process improvement going forward.
- Defect management. Knowledge of how and when defects were introduced can be used to improve the test process for future deployments.
- Test completion reports. After testing is complete test completion reports should contain a 'lessons learned' section to identify aspects of testing that can be improved.
- Release management reports. After releases have been deployed to production release managers may compile reports based on interviews with customers to evaluate the success of the release.

3.15.2 Measuring the value of testing

Measurement is the first step that leads to control and eventually to improvement.

As stated in Section 3.1– Objectives of Testing, the primary objective of testing is to “*reduce the likelihood of Queensland Health business operations being negatively impacted by the implementation of new or changed ICT products and/or services.*”

Measuring the value of testing in terms of impacts to business operations may be supported by:

- Measuring the quantity and severity of defects (detected as a result of testing) and the phase of testing they were detected in. Defects detected earlier in a project phase are in general far cheaper to rectify than defects which are detected late.
- Measuring the cost of undetected defects that were deployed to production which resulted in impacts to business operations. These costs can be balanced against decisions regarding whether to invest more in testing in the future.
- Measuring requirements coverage. For mission critical systems substantial coverage may be required in order to build the necessary confidence to proceed with a deployment.
- Measuring the numbers of issues reported by customers (service incidents). Successful testing would ideally see no change in (or a reduction in) the pattern of service incidents after a deployment has occurred.

3.16 Test environments

In alignment with best practice testing standards, a description of test environments (including test data) should be captured in the test planning documents.

The description should include a discussion of any limitations of the test environments which may impact the objectives of testing.

In general test environments should replicate production as closely as possible. (As appropriate in consideration of context in accordance with requirement 5.3 of the ICT Testing Policy.)

Configuration management of test environments should be closely managed and coordinated in consultation with the test manager.

3.17 Test data

Test data should be managed in accordance with the Data Management Policy.

In general test data should replicate production data as closely as possible. (As appropriate in consideration of context in accordance with requirement 5.3 of the ICT Testing Policy.)

The use of production data for testing purposes may occur when necessary to support the objectives of testing where permission from the data custodian (or delegate) has been given and where such use is consistent with the provisions of the Hospital and Health Boards Act 2011 (section 161).

3.18 Test asset reuse

In alignment with best practice testing standards there should be a strategy for test asset reuse.

Test assets are expensive to develop and should be structured with a view to as much reuse as possible over the project or service lifecycle.

The master test plan (or test strategy) guides appropriate re-use of these assets across the whole of asset lifecycle.

Test assets which should be reused are:

- Test cases - It is expected that a set of regression test cases will be defined and maintained in an appropriate testing tool (e.g. HP ALM - Quality Centre).
- Test environments (including test data)
- Test procedure documentation (e.g. Defect management procedure, test execution procedure)

- Test documentation templates (e.g. Test plan templates, test case templates, test report templates)
- Any other test collateral the test manager is able to efficiently reuse.

3.19 Test tools

In alignment with best practice testing standards and in accordance with requirements 5.3 and 5.8 of the ICT Testing Policy, appropriate test tools should be used to manage and store test cases and test execution logs.

Tools should be selected with due consideration given to all relevant contextual attributes, including:

- test objectives
- cost
- auditability
- traceability
- maintainability
- supportability
- reporting requirements

Tools selected should be supported by appropriate training.

The management of the tools should be appropriately resourced.

3.19.1 Test automation tools

Integration of test automation tools should be considered on a cost/benefit basis where the anticipated frequency of releases and the associated cost of manual regression testing is balanced against the cost of developing and maintaining an automated regression testing capability.

3.19.2 Performance testing tools

Integration of performance testing tools should be considered on a cost/benefit basis where the anticipated benefits of performance testing (including assisting decisions to select vendors and ongoing monitoring of vendor deliverables) are balanced against the cost of developing and maintaining a performance testing capability.

4. Legislation or related policies

- ICT Testing Policy
- Data Management Policy

5. Supporting documents

- Software Testing (ISO/IEC/IEEE 29119)
- Standard for Software Reviews and Audits (IEEE 1028)
- Health Informatics – Guidance on standards for enabling safety in health software (ISO/TR 17791:2013)

6. Definitions

Term	Definition
eHealth Queensland ICT Testing Service	(Formerly known as Innovation & Assurance – I&A.) The ICT Testing Service maintains the ICT Testing Policy and associated testing framework documents (including templates, guides and procedures)

Term	Definition
	to support best practice in ICT testing. http://qheps.health.qld.gov.au/icttesting
Health Software	Software used in the health sector that can have an impact on the health and healthcare of a subject of care.
ICT Products and/or Services	ICT products and/or services generally cover all types of technology (data, voice, video, etc.) and associated resources, which relate to the capture, storage, retrieval, transfer, communication or dissemination of information through the use of electronic media. All resources required for the implementation of ICT are encompassed, namely equipment, software, facilities and services, including telecommunications products and services that carry voice and/or data.
Test Deliverables	Test deliverables (i.e. test artefacts) are test work products that have been agreed to be communicated to stakeholders
Test Levels	A test level is a specific phase of testing with its own objectives and criteria. Test levels are usually defined by the type of testing or the phase of the development cycle (e.g. Levels may typically be: unit testing, integration testing, system testing, user acceptance testing)
Test Work Products	Test work products describe how the system is tested (e.g., test strategies and plans), actually test the system (e.g., manual and automated tests), or present test results (e.g., test dashboards and reports)

Version Control

Version	Date	Comments
1.0	23 March 2017	Approved CTO