THE CHANGE CONTROL IN AIRCRAFT TESTING

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Abstract

The paper has been intended to describe the essence of the change control in the aircraft testing, the change control being a component of the process of configuration management process. The concept of a systemic approach to the change control under the configuration management (CM) model has been presented. The essence of establishing the configuration of reference being the base for realization of tests has been indicated and necessity of control was justified. Decomposition of tests to objects of configuration has been created. The exemplary externals that have an effect on identified object of configuration have been described. It was assumed that the differences between real and supposed parameters of externals are the reason of changes to established configuration of testing. The algorithm of proceeding referred to implementation changes (initiating, description, estimation of the influence, taking a decision about implementation, messaging information to interested parties) has been proposed. The instruments for control of tests configuration has been presented. It was proved that efficient control of configuration could be an instrument for efficient realization of tests while changes appear. What has been proposed is a process of qualitative assessment of the change control as one of the most essential issues of the configuration management modelling in the aircraft testing.

Keywords*: configuration, configuration management, change, change control*

1. Introduction

There are situations in the aircraft testing process that compel the aircraft testing personnel to perform particular stages of the process in a way different from pre-planned. The variety of tasks, a large number of people engaged in the project, multiplicity and changeability of means/measures and conditions of performing the tests are the most fundamental reasons for that.

aircraft design and tests planning.

Depending on the stage of performing aircraft tests, a need to make changes in processes of planning and performing the tests may result from:

- weather conditions,
- availability of equipment and personnel,
- personnel competence,
- serviceability of the equipment to be used in the testing work,
- findings of earlier tests,
- completeness of the already performed tests.

All the above-mentioned factors may affect the testing work individually or as a whole. They may also interact.

Any changes introduced in the course of the testing work most often result from the need to repeat some tests. The fact, if occurs, usually effects extension of the testing time and increase in cost, which in particular affects flight tests. Therefore, an economic aspect is one of the most significant features given consideration while assessing probable effect(s) of the proposed change, and while taking decision on introducing the change in question.

Other aspects given consideration with respect to changes to be made are as follows:

– possibility to perform the tests,
– a sequence of tests,
– utilisation of the test site.

Changes in the testing work are different in the air (flight tests) and on the ground (ground tests). The greatest cost is generated by changes in the air, i.e. in flight tests. No matter what the scope of changes is, all the tests performed on the ground need to be completed with a positive effect. Only successful results would allow transition to flight tests.

Configuration management is a significant tool to be used in the change control.

2. The essence of the change control in the management of aircraft testing

The aircraft-testing configuration (interrelated functional and physical attributes of aircraft testing defined in the information on configuration [5]) is usually understood as interrelated functional and physical attributes of the testing process, defined in documents that describe this process, and verified in the course of the testing work [2, 5, 11]. Documents used in the course of the testing work are subject to continual changes that should be controlled. This is an element of the configuration management (CM - formal approach to configuration control/management [5]) process, which provides clarity, mainly in the planning, in how the testing proceeds and in documenting the testing evidence, in particular, after changes [11, 9].

Configuration audits are an indispensable component of the CM, one that considerably affects the change control. The configuration audits (functional (physical) configuration audit – formal assessment to verify whether the configuration item has already gained functional (physical) attributes specified in the information on aircraft testing configuration [5]) are expected to confirm that the results of the completed testing work are reliable after changes were introduced.

A key role the CM has to play is to provide current information on how the aircraft testing proceeds, i.e. to generate and maintain such a system, which will inform on functional and physical features of this service with full identifiability within some pre-set scope. The effective CM enables the schedule to be effectively followed when changes are introduced, providing at the same time that particular stages of the testing work (test methods) and the data output thereof are well documented.

While performing tests, changes are generated that are documented and recorded with respect to the set up reference configuration (reference configuration – the approved information on aircraft testing configuration, which specifies aircraft testing attributes at a given time and serves as reference for further aircraft testing [5]).

The setting up of a proper reference configuration generates a need for conducting formal reviews before the reference configuration is approved. These reviews are expected to verify the completeness and correctness of already made arrangements, with account taken of any already approved changes and discrepancies that occur while performing the aircraft testing.

The configuration management, including the change control, refers to the aircraft testing as a whole; it may also refer to particular stages or methods. Determination of the aircraft testing structure and identification of configuration items (CIs - a component treated as a self-contained unit within the configuration, which performs its final function [5]) that should be managed individually with respect to the planning thereof, to how they proceed and should be documented,

and to the introduction of changes are both indispensable to correctly perform the testing work.

With account taken of the already gained experience in the aircraft testing, one should consider the following CIs: flight tests and ground tests [6]. Both may have their effect upon quality and time of performing the aircraft testing.

The following CIs can be distinguished in aircraft ground testing:

– checks of the aircraft documentation,
– checks of configuration of aircraft/aircrew systems/devices after completion,
– checks of geometrical data of the aircraft, and of aircraft control data,
– tests of aircraft systems and equipment,
– checks of reliability,
– checks of maintainability of systems/assemblies.

The following CIs can be distinguished in aircraft flight testing:

– performance testing,
– flying qualities testing,
– power plant testing,
– systems/equipment testing,
– armament testing.

The Configuration Status Accounting (formalised recording and reporting on the aircraft testing configuration, status of proposed changes, and status of the process of introducing the approved changes [5]) is an area of particular significance, since the configuration status, if properly defined at the very beginning of the aircraft testing, takes intended effects while performing the aircraft testing, introducing changes to the testing work, reviewing the process, approving the reference configuration, and organising configuration audits.

The Authors' experience shows the aircraft flight testing is the most sensitive Configuration Item (CI), in particular to changes that may often occur for some reasons beyond control of the aircraft testing participants. The CI sensitiveness is extremely versatile in its nature, mainly with respect to security, realizability, and cost. The flight test planning offers a chance to optimise all the above-mentioned aspects. The process of performing the flight testing is heavily burdened with continual changes resulting from, among other things:

– aircraft readiness,
– pilot skills,
– weather conditions,
– aircraft health/maintenance status,
– capabilities to install measuring equipment.

With account taken of the analysed stage of aircraft testing, with the following items well defined, i.e.:

– scope of testing work,
– principles of test planning,
– tested features/characteristics,
– testing methods,

the Authors have become convinced that the change control for the identified item in between the approved reference configurations is an area of significance in the aircraft-testing configuration management process.

The basic principle is that all changes are controlled after first information on the aircraft testing configuration has been released, no matter at what stage of the testing work.

What affects the change-control level in the process of introducing the proposed change or the issue of clearance is as follows:

– how the testing work proceeds and realizability thereof,
– the testing stage imposed requirements,
– the type of already set up reference configuration.

The change control process should be well documented. The documentation level depends on the type of a proposed change and on whether it has any impact on the reference configuration or not. Despite the documentation level, any change should include:
- description, reason, and notification,
- change classification with respect to its complexity, resources, and planning,
- assessment/evaluation of effects of this change,
- cost and how it affects the project,
- details on the recommended change management,
- details on the recommended change introduction and verification.

The change control process comprises what follows:
- the change initiation,
- the assessment of the change,
- decision on the change,
- introduction and verification of the change.

The change can be initiated by the test specialist, designer, maintenance staff, or a pilot. All change proposals are identified and documented before they are submitted to the test organiser for assessment.

Change proposals should include the following information:
- configuration item(s) and related information subject to the change together with all details of the name(s) and present status of changes,
- description of the proposed change,
- details on other items of configuration or information the proposed change may affect,
- the party interested in and preparing the change, date of change preparation,
- reason for the change,
- category of the change.

The correctly initiated change should be assessed. The assessment should be documented. As far as the assessment is concerned, the complexity of the item and category of the change should be taken as the basis.

The assessment should include:
- the technological essence of the change,
- the change-attributed risk,
- potential effect on the contract, schedule, and cost.

Furthermore, the following factors should be taken into account to determine the effect(s) of the change:
- appropriate legal requirements, rules and regulations,
- interchangeability of configuration items and the need for re-identification,
- interrelationships between configuration items,
- methods of manufacture, testing, and monitoring,
- assets at hand and purchases,
- delivery-related actions,
- customer-support related requirements.

The process of making decisions on the change should be allocated to the decision-making body for each of the proposed changes.

What should be taken into account in the decision-making process is category of the proposed change. After the change has been assessed, the decision-making body should review the assessment and take their decision on the change. The decision should be recorded. Full communication should be provided. Notification of the decision taken should reach all the interested parties engaged in the aircraft testing.

Introduction of the approved change requires:
- changes in the information on configuration of the product, delivered to appropriate parties engaged in the aircraft testing, and
- actions undertaken by the interested parties (within the organisation and beyond) which are concerned about the change.

3. The model of configuration management process in aircraft testing

The change control is possible if all the configuration management areas are well defined. The configuration identification, including the action planning and status description are indispensable for the planning, implementation, and evaluation of the intended/proposed changes.

The change control is a crucial process in the CM process model in the aircraft testing (Fig. 1). It takes account of all essential qualitative assessments of the CM related actions undertaken in the aircraft testing.

While grouping processes under the CM model in the aircraft testing, denoted with β_k, of vital importance are requirements resulting from the CM (with account taken of interrelationships between these actions) and from the execution of the aircraft testing process, i.e. $W_{k,\,N}$ where: k – the process number (in the model: 1 – 9), N – the process requirement number.

Taking Fig. 1 and [5, 10] into consideration, the following processes, β_k, have been identified, ones that describe qualitative requirements under the CM. So,

- β_1 – determination of responsibilities for the configuration management,
- β_2 – configuration management (CM) planning,
- β_3 – configuration identification – structure of the aircraft testing and selection of configuration items,
- β_4 – configuration identification – information on the aircraft testing configuration, identification of methods, how to denote documents,
- β_5 – configuration identification – setting up the reference configuration,
- β_6 – control of changes that occur in the course of aircraft testing,
- β_7 – description of the aircraft-testing configuration status,
- β_8 – configuration audits – an audit of the functional configuration of the aircraft testing,
- β_9 – configuration audits – an audit of the physical configuration of the aircraft testing.

In the CM process model, the inputs to particular processes have been determined as a result of the assessment of requirements $W_{k,N}(t)$, where: k – the process number, N – the process requirement number. Assessments of these processes $\beta_k(t)$ are to be found at the outputs from these processes. The assessment of the CM as a whole is a function of assessments of particular processes $B(t)$.

4. Qualitative requirements of the change control process in the aircraft testing

The change control process has been presented in Fig. 2. A key issue is in this case description of the above identified requirements $W_{k,N}$ and assessment thereof.

The assessment of qualitative requirements of the $W_{6,1}(t)$ input items in the area of change initiation should cover what follows:

- allocation of authority to initiate changes,
- determination of categories of changes,
- introduction of procedure(s) adequate to the change category(-ies),
- determination of impact of the change on other configuration items,
- determination of reasons for the change.

The assessment of qualitative requirements of the $W_{6,2}(t)$ input items in the area of change assessment should cover what follows:

- the technological essence of the proposed change, impact thereof on the possibility to perform the testing work,
- potential impact on the programme/schedule of the testing work,
- impact thereof on the testing work cost,
- interchangeability of configuration items and the need for re-identification,
- interrelationships between configuration items,
- testing methods, validation and quality control capabilities,
- assets at hand and purchases,
- actions aimed at redelivery of assets indispensable for the testing.

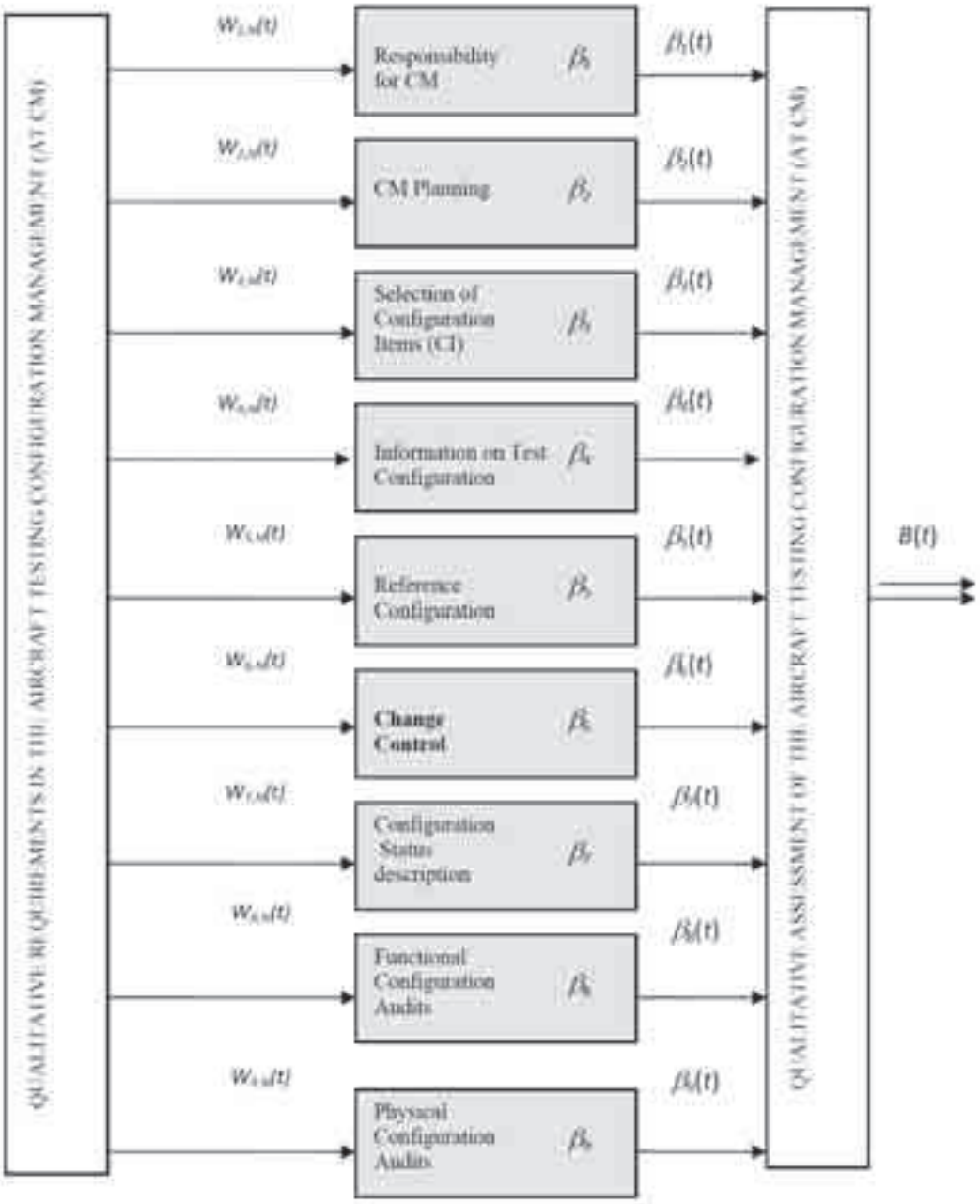

Fig. 1. The Configuration Management (CM) Process Model in the aircraft testing (own studies based on [6])

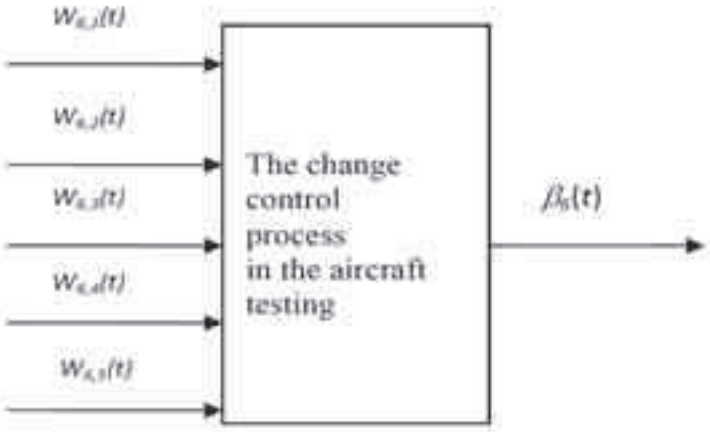

Fig. 2. The change control process (own studies based on [6])

The assessment of qualitative requirements of the $W_{6,3}(t)$ input items in the area of taking decision(s) on the change should cover what follows:
- allocation of responsibility for the decision making,
- determination of decision-making levels depending on the change category,
- the need for notification of change approval.

The assessment of qualitative requirements of the $W_{6.4}(t)$ input items in the area of change introduction and verification should cover what follows:
- allocation of responsibility for the introduction of changes,
- verification of the change introduction,
- assessment of actual effects of the change,
- evaluation of the change-generated cost.

The assessment of qualitative requirements of the $W_{6.5}(t)$ input items in the area of documenting the changes should cover what follows:
- setting up a documented procedure of the change control,
- determination of forms of records on the changes, initiation, assessment, and verification thereof.

5. To recapitulate

The above-presented configuration management (CM) process model as applied to aircraft testing can be used to effectively plan, conduct, and document testing methods and results gained, including the change control.

The presented instance of the qualitative assessment of the change control process does not exhaust the scope of the configuration management related question; it does not fully reflect the essence of the concept, either. The change control process is a crucial issue in performing the aircraft testing because of the very special nature of performing the tests, including the flight-test cost.

The qualitative assessment of the configuration management processes is expected to answer the question whether results gained are complete, reliable, and refer to the pre-planned actions and follow the specified requirements.

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