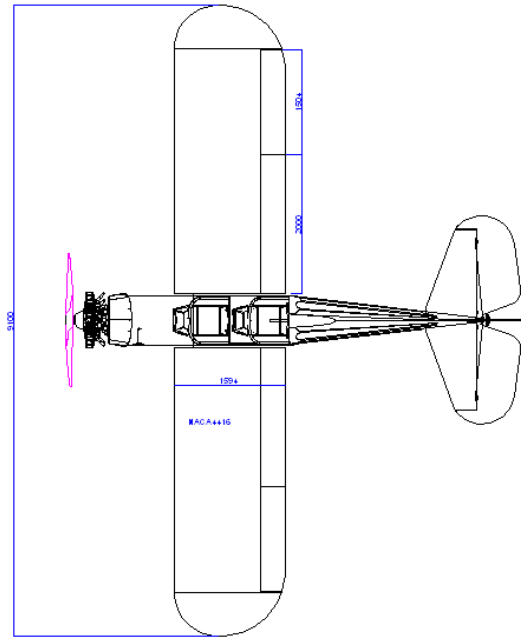
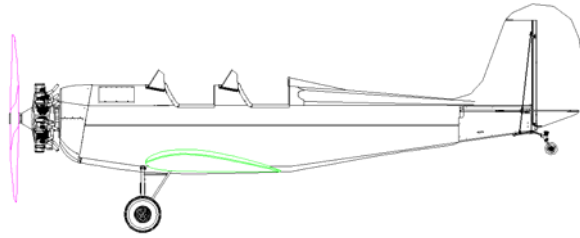




SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012



WING COMPLIANCE DOCUMENT

Prepared by:

Camillo PEDETTI



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

SUMMARY

This document constitutes the Qualification Plan (QP) of the LoCamp Wing Structure. The description of the approach that will be used in the relevant qualification process is reported as well.

The present document is subdivided in four parts:

- The first part provides a description of the Wing structure.
- The second part describes the qualification approach that Aerolab will pursue for the wing qualification.
- The third part is the "Compliance Check List", that defines for each applicably regulation requirement listed in the qualification basis the relevant "Mean of Compliance" (MoC) with the evidence of compliance.
- The last part provides the list of the deliverable items (i.e. mainly documents: analysis report, test proposals, test plans, test reports, etc. that contain the compliance evidence against the certification requirements).



- INDEX	3
REFERENCES	4
LIST OF ABBREVIATIONS	5
- INTRODUCTION	6
- WING DESCRIPTION	8
- DESCRIPTION OF THE CERTIFICATION APPROACH	10
- Loads determination and stress analysis	10
- Static strength substantiation	10
- Metallic materials selection	10
- Metallic structures design verification approach	10
- Full-scale static test of metallic structures	10
- Description of the means of compliance	10
- Determination of the aerodynamic loads	11
- Determination of the design mass/CG inertia distributions	11
- Determination of the design loads criteria	11
Determination of the flight design loads	11
- Structural analysis description	11
- Global finite element model	12
- Detailed stress analysis	13
- Approach to structural substantiation	13
- Ground tests	13
- TESTS DESCRIPTION	14
- Test environmental conditions	14
- Test rig description	14
- Test article instrumentation	14
- Test documentation	14
- COMPLIANCE CHECK LIST	15
- SUMMARY OF THE APPLICABLE DOCUMENTS/REPORTS	17
- CONCLUSIONS	17



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

- REFERENCES

FAA documents

- 1) FAR PART 23 -- Airworthiness Standards: Category Airplanes

European Aviation Safety Agency Documents (EASA)

- 2) CS-VLA: Certification Specifications for Very Light Aeroplanes
- 3) NPA 25D-286: Material Strength Properties

ASTM Documents

1. ASTM F2245-06: Standard Specification for Design and Performance of a Light Sport Airplane



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

- LIST OF ABBREVIATIONS

AC	Advisory Circular
A/C	Aircraft
AFT	Aftward
CP	Certification Plan
CRES	Corrosion Resistant Steel
CRI	Certification Review Item
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FAR	Federal Airworthiness Regulation
FE	Finite Element
FEA	Finite Element Analysis
FEM	Finite Element Model
FWD	Forward
LHS	Left Hand Side
LL	Limit Load
N/A	Not Applicable
NDI	Non Destructive Inspection
RHS	Right Hand Side
TBC	To be confirmed
TBD	To be defined
TP	Test Plan/Test Proposal
TR	Test Report
UL	Ultimate Load



- INTRODUCTION

This document constitutes the Qualification Plan (QP) of the Aerolab Mfg, Inc. LoCamp Wing structure. It contains the description of the approach that will be used in the qualification process of the wing.

This document provides also the proposed list of means of compliance versus the certification requirements.

- Terminology definition

Here below the definition of the terms that are commonly used within this document are reported. In this document with the term "certification process" we consider the evidences provided for Qualification, Certification and Homologation.

- **Qualification**: The process of verifying and declaring conformity with each specification requirement at all levels (Fitness for Purpose).
- **Certification**: The process of verifying and declaring compliance with each airworthiness requirement at all levels (Fitness for Flight).
- **Homologation**: Formal declaration, granted by Authority, that the product complies with every specification requirement and applicable regulations, at all levels. The homologation process is formally ended with the issue of a *Type Certificate, released* by the Certification Authority

- Compliance documentation

The linking of the certification requirements with the compliance documentation is made through a Compliance Check List (CCL). The CCL, is contained in chapter 4, it has a tabular format and contains information like:

- Airworthiness requirements,
- Mean of compliance,
- Compliance statement/compliance documentation or reference to any qualification evidence.

The compliance with all the airworthiness requirements will be shown throughout the release of a series of documents, in particular:

Analysis report: this document contains mainly the written evidence of the performed analysis. The reliability of the methods used is demonstrated by the previous experience supported by test data or dedicated evidences.

Test Proposal/Test Plan: this document contains the information useful for the test execution, including:

- test article definition
- applied loads
- test condition
- test instrumentation
- test set-up requirements.



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

Test Report: this document contains the engineering evaluation of the test results stating the validity of the test results to get the minimum structural evidence for the certification purpose.

Drawings and Specification: these documents are that for which the compliance is generally obtained by inspection, i.e. the verification is made checking the documentation.

Drawings and specification: these documents are that for which the compliance is generally obtained by inspection, i.e. the verification is made checking the documentation.

- Authorities witnessing

The "Certification Authority" have to be keep informed, about the planning of the activities, to allow them to decide which tests they intend to witness and those where witnessing is delegated.



- WING DESCRIPTION

This paragraph describes Wing structure for which structural substantiation is reported in this Qualification Plan.

Wing geometrical data

- Wing airfoil: NACA 4416
- Wing surface area: 14.91 m² (ref. 1)
- Wing span: 9.1 m (ref. 1)
- Aspect ratio: 4.8 (ref. 1)
- Taper ratio: 1 (ref. 1)
- Wing aerodynamic center location (% MAC): $X_{AC} = 0.244m$
- MTOW = 600 Kg
- $n_z = +4, -2g$

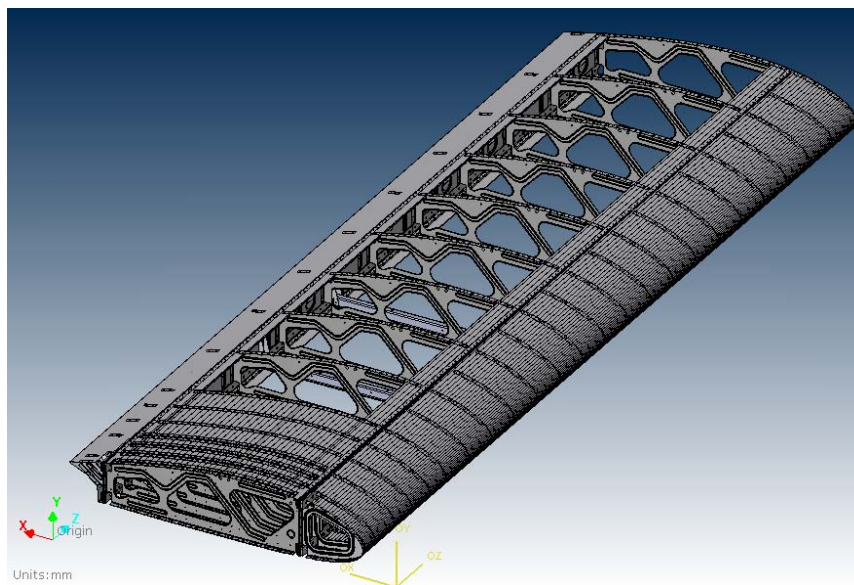


Fig. 1 - Wing assy, view from top



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

- Overall description of the Wing

The wing is a two longerons structure with metallic formed ribs and skin that is partially metallic and partially fabric. The flap and the aileron have both metallic structure and fabric skin.

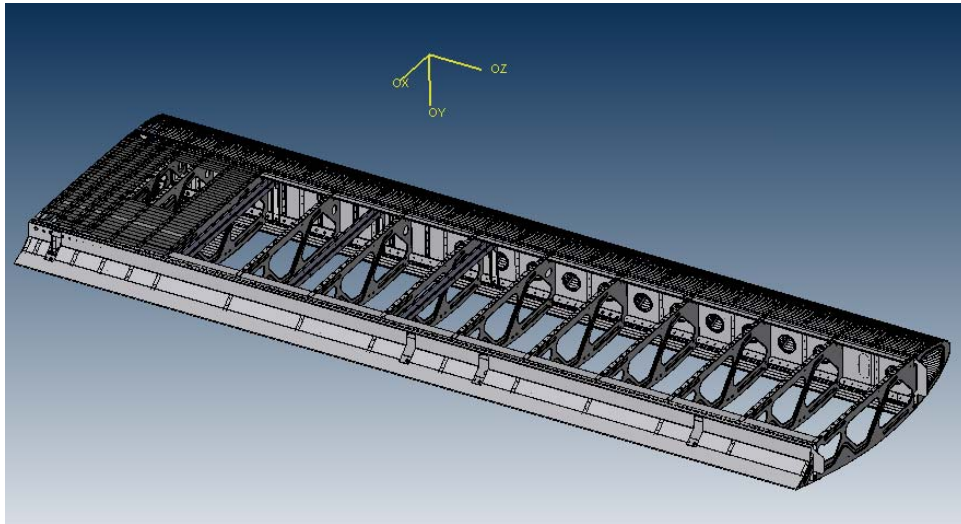


Fig. 1 - Wing assy, view from bottom



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

- DESCRIPTION OF THE CERTIFICATION APPROACH

- Generality

The approach used in the certification process of the LoCamp Wing structure is based on both analytical and testing activities.

Aerolab will mainly use the analytical approach in the determination of the internal loads and stresses with FEM and dedicated pre and post processing SW starting from external loads defined.

With the terminology "external loads" we consider the loads acting on the wing and due to aerodynamic loads, inertia loads, etc. In analogy, for "internal loads" we consider the loads exchanged by two elements of the wing.

- Loads determination and stress analysis

Aerolab under its own responsibility compute the flight loads, therefore the validation/certification of the flight loads are not part of this Qualification Plan.

The analytical approach is used by Aerolab for the calculation of the internal loads. This is performed mainly by the use of finite element models.

- Static strength substantiation

- Metallic materials selection

The static strength approach for the metallic material used is in line with the common aerospace industrial practice.

A selection of the most used metallic materials in the design is reported below. All the material strength properties and design values are obtained from MMPDS-03 or ALCOA datasheets.

Aluminium alloys

- 6082-T6 Bent sheets
- 2024-T3 Pressed sheets
- 7050-T3 Machined parts

Steel

- 4130 N Tubes

The selection of metallic material has been derived for the specific purpose of the LoCamp Wing design goals.



- Metallic structures design verification approach

All the parts that are primary structural elements are substantiated by a combination of theoretical analysis and tests. Analysis will be used for the determination of the critical areas of the structure, and the associated loading conditions.

The demonstration by analysis will be used for all the structural parts for which the analytical methods (internal load calculation and computation of the margin of safety) have been demonstrated reliable by past experience.

- Full-scale static test of metallic structures

The Wing is assumed to be a primary structure therefore the full scale static test is required.

- Description of the means of compliance

In the following paragraph the technical steps of the "qualification process", for the LoCamp Wing structure, that will be used in the qualification are described. Within each step the way to obtain the technical evidence and the means of compliance that will be produced for the "qualification process" are defined.

For a better understanding the LoCamp Wing structural substantiation has been divided in the following topics:

- Application of the inertia loads
- Determination of the design mass/CG inertia distributions
- Determination of the design loads
- Definition of the flight design loads
- Static stress analysis
- Finite element model management and calculation of the internal loads
- Definition of the design critical loading conditions
- Detailed static stress analysis
- Testing activities
- Testing activities for static strength substantiation

- Determination of the aerodynamic loads

Aerolab performs the determination of the aerodynamic loads.

- Determination of the design mass/CG inertia distributions

The mass/CG/inertia distributions (for the design, analysis, and testing) are obtained from analytical calculation. To be conservative in the inertia loads definition for the wing, the MTOW is considered without wing weight subtraction.

- Determination of the design loads criteria

Under this paragraph are listed all the activities, and subsequently all the deliverable items, that are required to define the design loads for the aircraft.



- Determination of the flight design loads

Two main flight load are considered: symmetrical manoeuvre at max n_z and the max torque due to the rolling pull-out manoeuvre. The max drag is also considered.

- Structural analysis description

With the term "structural analysis" we consider all the activities, starting from the design loads (flight, ground, etc.), that are necessary to determine the internal loads, the detailed local stress distribution and Margin of Safety (M.S.) calculation.

The kind of structural analysis performed is mainly the following:

- selection of the design loading conditions,
- global finite elements model loading,
- internal loads calculation,
- detailed stress analysis,
- FEM model validation.

The structural analysis will assess the ability of the Wing to support the critical loads and to meet the specified strength requirements.

The selection of the design loading conditions is the engineering activity that starting from all the loading conditions applicable to the aircraft, defines the subset of the loading conditions that have to be used in the design of the structural parts. In this kind of process are mainly included the definition of the flight and ground loading conditions.

The "structural analysis" is carried out mainly using a global Finite Element Model. This model is representative of the whole Wing structure. The model is detailed to a sufficient level to allow the calculation of the internal load distribution in all the parts.

The FEM is loaded with inertia and aerodynamic loads covering the Flight Load.

The internal loads obtained from the output of the NASTRAN run are used to perform the stress check (i.e. calculation of the M.S.). This activity, as before mentioned, is performed using specific computer codes, spreadsheet calculation and hand made calculation, implementing comprehensive standard public library of procedures and techniques, for the various structural analysis required: instability conditions, analytical stresses, strains, deflection and stiffness, M.S. calculation etc.

A crucial step in the stress analysis activities is the FEM validation. This activity has the purpose to demonstrate that the analytical methods are reliable and can be used to show compliance for the strength substantiation. When it is possible to achieve a good confidence in the using of the analytical model the need of testing evidence can be relaxed and in some cases could be not necessary to show the strength capability.



- Global finite element model

The global finite element model (Global FEM) represents the primary structure of whole Wing.

The structure is represented mainly by bi-dimensional elements (QUAD4 and TRIA3) and mono-dimensional (BAR and ROD). The bi-dimensional elements are used to represent the skin, the spar webs, while the mono-dimensional elements are used to represent the stiffeners, the spar caps, or the ribs elements.

- Detailed stress analysis

The detailed stress analysis is performed mainly to perform the check stress and calculate the Margin of Safety.

The methodologies used in the calculation are the classical stress analysis methods. To perform the detailed stress analysis are used the internal loads computed using the global finite elements model (Global FEM).

The following documentation will be issued:

- 1) Rpt. LW-001 – "Wing Check Stress Notes ".

- Approach to structural substantiation

- Ground tests

The general option chosen for the route to certification of the Aerolab Wing structure is to provide qualification evidences by analysis supported by test evidences.

This paragraph defines the ground test program to be carried out in order to support the "Wing qualification process".

The following scheme (table 1) shows the test activities that will be carried out during the LoCamp Wing and its support beam program development, in order to provide evidences for the "certification process".

TABLE 1 - STRUCTURAL TESTS PROGRAM
Design static test up to U.L.

The tests will qualify the wing to the Specification Requirements providing evidence of functioning within the specified requirements. Test articles and test set-up will be conformed so that test results can be used to support certification too.



- TESTS DESCRIPTION

The present chapter provides a synthetic description of the test criteria and arrangement for each test that will be performed to support the LoCamp Wing structure qualification.

The tests are subdivided into the followings main categories:

- Static tests,

- Static tests

The test listed in this section is that, which purpose is to demonstrate compliance of the structural components static strength, versus the requirements.

The planned static test is the following:

- wing structure static test up to L.L.
- Wing structure static test up to U.L.

- Test environmental conditions

The test will be done at Room Temperature.

- Test rig description

The tests will be done installing the wing on a support representing the stiffness of the two centre frames connecting the wing to the fuselage truss.

- Test article instrumentation

The maximum deflection at the wing tip will be measured.

- Test documentation

All the aspects of the test shall be properly described by a dedicated set of documents. The documentation will include:

Test Plan providing the following data:

- Test load condition description and rationale for choosing,
- Test article configuration description,
- Test rig arrangement description,

Test Report providing the following data:

- Test outputs,
- Test outputs evaluation,
- NDI and measurement report.



- COMPLIANCE CHECK LIST

The Compliance Check List included here is for the management of the qualification requirements.

The following fields constitute the Compliance Check List:

- **RULE PARA ID** - indicates the identifier of the requirement.
- **RULE TEXT** - is the requirement title/test.
- **MoC** - Means of Compliance as follows (in the attribute will be inserted the CODE as listed in table 5).
- **DOC NUMBER** - is the number of a compliance document.
- **DOC TITLE** - is the title of a compliance document or contains a compliance statement.
- **REMARKS** - is the annotation field.

TABLE 2 - DEFINITION OF MEANS OF COMPLAINE

MOC	DESCRIPTION	CODE
Compliance Statement	Providing general statement indicating compliance to a requirement.	0
Demonstration	Architectural description of a system indicating compliance to a requirement.	1
Calculation/Analysis	Compliance demonstration by analytical means such as stress report, thermal analysis or analysis supporting the interpretation of test results.	2
Safety Assessment	Compliance demonstrations by qualitative and/or quantitative hazard safety assessments.	3
Lab Test, Rig Test	Compliance demonstration by Lab Test /Rig Test including the Test Plan and Test Results Reports.	4
Ground Test	Compliance demonstration by ground test on A/C including the Test Plan and Test Results Reports.	5
A/C Flight Test	Compliance demonstration by flight test including the Test Plan and Test Results Reports.	6
Inspection	Compliance demonstration by review of design details and by physically inspecting the installation.	7
Modeling/Simulation	Compliance demonstration by simulation either by lab means or by computer codes (either integrated or not integrated with electrical and/or electronic equipment).	8
QPP Document (Equipment QPP at System level)	Demonstration including, for the specific component, a functional compliance demonstration to the requirements of the relevant specification.	9



TABLE 3 - COMPLIANCE CHECK LIST for CS-VLA

Rule para	Rule Title/Text	MoC	Document Number	Document Title	Remarks
Strength substantiation					
301	Loads	2	LW-001	Wing Stress Check Notes	
303	Factor of safety	2	LW-001	Wing Stress Check Notes	
305	Strength and deformation	2,4	LW-001	Wing Stress Check Notes	
307	Proof of structure	2,4	LW-001	Wing Stress Check Notes	
Materials					
603	Materials	0			Applicable drawing
605	Fabrication Methods	1			Applicable drawing and methods
613	Material strength properties and design values	0			MMPDS-03 and Alcoa datasheet
615	Design Properties	0			
625	Fitting Factor	2	LW-001	Wing Stress Check Notes	



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

TABLE 4 - COMPLIANCE CHECK LIST for ASTM F2245-06

Rule para	Rule Title/Text	MoC	Document Number	Document Title	Remarks
Strength substantiation					
5.1.1.4	Loads	2	LW-001	Wing Stress Check Notes	
5.1.2	Factor of safety	2	LW-001	Wing Stress Check Notes	
5.1.3	Strength and deformation	2,4	LW-001	Wing Stress Check Notes	
5.1.4 / 6.8	Proof of structure	2,4	LW-001	Wing Stress Check Notes	
Materials					
6.2	Materials	0			Applicable drawing
6.3	Fabrication Methods	1			Applicable drawing and methods



SPORT CAMPER
Technical Report
Model: LoCamp

Report N°: LW-000
Rev: 0
Date: 01 Feb 2012

- SUMMARY OF THE APPLICABLE DOCUMENTS/REPORTS

This paragraph contains the preliminary list of the documents/reports, which provide the written evidence to demonstrate the compliance to the certification requirements.

TABLE 5 - LIST OF DELIVERABLE ITEMS

Document Number And Title	Status	Owner	Note
Aerodynamic reports			
- 57-001 R0 Aerodynamics Characteristics Calculation	Delivered	AEROLAB	
- 57-002 R0 Aerodynamics Characteristics 4416 profile	Delivered	AEROLAB	
Design loads reports			
LW-001 Wing Check Stress Notes	Delivered	AEROLAB	
Static stress analysis reports			
LW-001 Wing Check Stress Notes	Delivered	AEROLAB	
TPW-001 Wing Test Plan	To be issued	AEROLAB	
TRW-001 Wing Test Report	To be issued	AEROLAB	

- CONCLUSIONS

This report provides qualification procedures to be accepted by Airworthiness Authority for the AEROLAB MFG, INC. LoCamp wing structure acceptance.