ZLIN AIRCRAFT
Letiště 1887
765 02 Otrokovice

www.zlinaircraft.eu

SERVICE LETTER No. L 119

DATE: October 26, 2018

TO: **Sault College Aviation Technology**

MODELS AFFECTED: **Z 242 L aircraft, S/N 0745, 0746**

SUBJECT: **Operation limits – Increase of safe life limit to 18 000 flight hours**

According to analysing the data from the AMU 1, with respect to actual:
- kind of operation,
- number of flight hours,
- number of landings,
- approved safe life limits for aircraft parts,

we determine as follows:

The aircraft can be operated **up to total safe life limit of 18 000 flight hours** according to special limits and instructions stated in the report Z242L-0574. Number of flight hours shall be calculated according to Aircraft Journey Log Book.
Recalculation of number of flight hours with respect to a difference between Aircraft Journey Log Book and AMU 1 records might be possible after final AMU 1 records evaluation in the end of aircraft safe life.

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Prof. Ing. Antonín Píštěk, CSc.
Head of Office of Airworthiness

Z 242L Assessment Report - Aircraft Safe-life prolongation up to 18 000 flight hours Sault College Aviation Technology

(Z 242L, S/N 0745 and Z 242L, S/N 0746)

Prepared by: T. Belohradsky
Stress Analysis Department

Approved by: L. Januška
Head of DOA

A. Pistek
Head of Office of Airworthiness

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Number of Appendices: 2

CONTENT

MARKING USED

FAR Part 23		Federal Aviation Regulations for Small Airplanes, USA
AFS-120-73-2		FAA Fatigue Evaluation of Wing and Associated Structure on Small Airplanes
AC23-13A		FAA Advisory circular for fatigue analyses and tests
AMU1		Acceleration Monitoring Unit
SFL		Safe Fatigue Life
FAA		Federal Aviation Administration of the USA
CAA		Civil Aviation Authority of the Great Britain
ZLIN-A		Measured operating loading spectrum for acrobatic category
ZLIN-N		Measured operating loading spectrum for normal category
CAA-FAA		CAA operation acrobatic spectrum for the Z 40 series, modified FAA
ENVELOPE		Safe envelope of loading spectrum Canada-Operation
SCAT		Sault College Aviation Technology
S-N curve		Fatigue curve (Wöhler curve)
n	[-]	Load factor according to the FAR 23
σ_{+1g}	[MPa]	Stress in flight at n = +1(g)
σ_{-1g}	[MPa]	Stress at the ground stay n = -1(g)
D_i	[1/hod]	Fatigue damage in individual phases of flight
D_C	[1/hod]	Total fatigue damage
L_B	[hod]	Safe fatigue life value
L_S	[hod]	Mean fatigue life value
j_N	[-]	Scatter factor
V_P	[km/h]	Average airspeed

1 INTRODUCTION

The Sault College Aviation Technology (SCAT) operates a fleet of 11 ZLIN Z 242L aircraft. The list of aircraft is available in the Table No.1-1 bellow.

Type [-]	S/N [-]	Reg. mark [-]	Flight hrs. (09/2018) [Hrs]	Landings (09/2018) [-]	Monitored by AMU1 [Hrs]	Acro (A) [Hrs]	Acro (U) [Hrs]	Acro (A+U) [Hrs]	Safe-life limit [%]
Z 242L	0679	C-FQHT	12094:36	12089	5761:12:00	–	–	–	36.02 %
Z 242L	0681	C-FANU	14293:18	13701	5049:20:00	–	–	–	35.67 %
Z 242L	0682	C-FHTU	15690:48	15023	9583:55:00	–	–	–	27.20 %
Z 242L	0683	C-FVWH	Out of operation						
Z 242L	0684	C-FCSB	15790:12	15287	11475:24:00	–	–	–	23.78 %
Z 242L	0685	C-FVWT	14999:18	14305	10275:25:00	–	–	–	33.40 %
Z 242L	0699	C-FZHF	2490:06	2296	1890:30:00	–	–	53:54:00	74.33 %
Z 242L	0742	C-GHXG	11393:54	11400	10986:00:00	–	–	–	64.62 %
Z 242L	0743	C-GHXG	4893:06	4388	3711:55:00	–	–	126:00:00	77.22 %
Z 242L	0744	C-GERR	4498:30	4054	4252:35:00	–	–	–	80.15 %
Z 242L	0745	C-GHXF	10391:24	9712	9983:35:00	–	–	–	66.48 %
Z 242L	0746	C-GJOR	10899:30	10248	10393:55:00	–	–	–	59.49 %

Table No. 1-1 ZLIN Z 242L operated by Sault College Aviation Technology

The basic operational life of the Z 242L aircraft is 5500 flight hours. The aircraft are monitored by the acceleration monitoring unit AMU1. Based on the AMU1 monitoring a new operational limit has been set in the year 2003 by the Report No. Z242L-0554, [1]. The operational limit was increased from 5500 to 11000 flight hours.

At present days the aircraft Z 242L, S/N 0745 and S/N 0746 are reaching the operational limit 11000 flight hours. The aim of this assessment report is to prove Safe Fatigue Life (SFL) of aircraft primary structure up to 18000 flight hours for aircraft Z 242L, S/N 0745 and S/N 0746 operated in aviation school Sault College Aviation Technology in Canada. The long times monitoring by AMU1 system is used as an input source for the aircraft prolongation.

2 Z 242L AIRCRAFT

2.1 Brief description of the Z 242L aircraft

The Z 242L aircraft (Fig. 2-1) is designed in the category A, U and N according to FAR Part 23 - Amdt. 23-36 inclusive.

The Z 242L aircraft is intended for basic and advanced training, acrobatic training and practice, practice in night and instrument flying and glider towing.

The Z 242L aircraft is a two-seats, low-wing, single engine, self-supporting monoplane of all metal structure with side by side seats. The aircraft is equipped with nose-wheel tricycle fixed landing gear.

The aircraft is powered with the TEXTRON Lycoming AEIO-360-A1B6 piston air cooled flat 4-cylindre engine with the MTV-9-B-C/C-188-18a hydraulic controlled three-blade constant speed propeller. The engine is not equipped with reducer and is capable for acrobatics and inverted flights. The propeller is made of wood with composite covering. The propeller is capable for acrobatic manoeuvres.

Dimensions	
Span	9.340 m
Length	6.940 m
Height	2.950 m

Table 2-1 Basic dimensions of the Z 242L aircraft

Category	Cent. of gr. (% MAC)	Max. take-off weight (kg)	Max. landing weight (kg)	Max. range of permissible maneuvering load factors (g)
Acrobatic (A)	19.0 - 24.5	970	970	+6.0 ; -3.50
Utility (U)	19.0 - 24.5	1020	1020	+4.4 ; -1.76
Normal (N)	19.0 - 26.0	1090	1050	+3.8 ; -1.52

Table 2-2 Centre of gravity position, weight, manoeuvring load factors

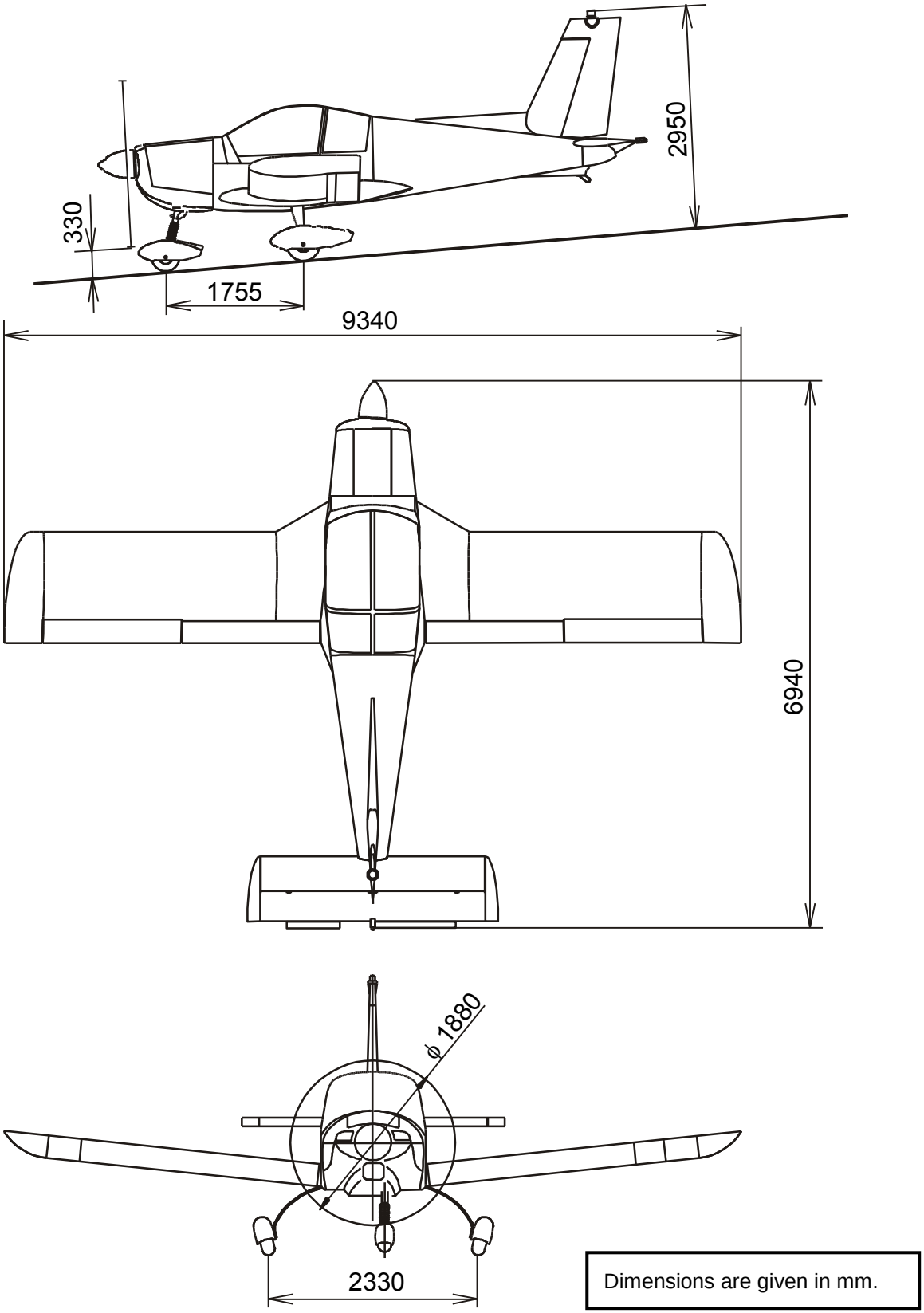


Fig. 2-1 Z 242L aircraft

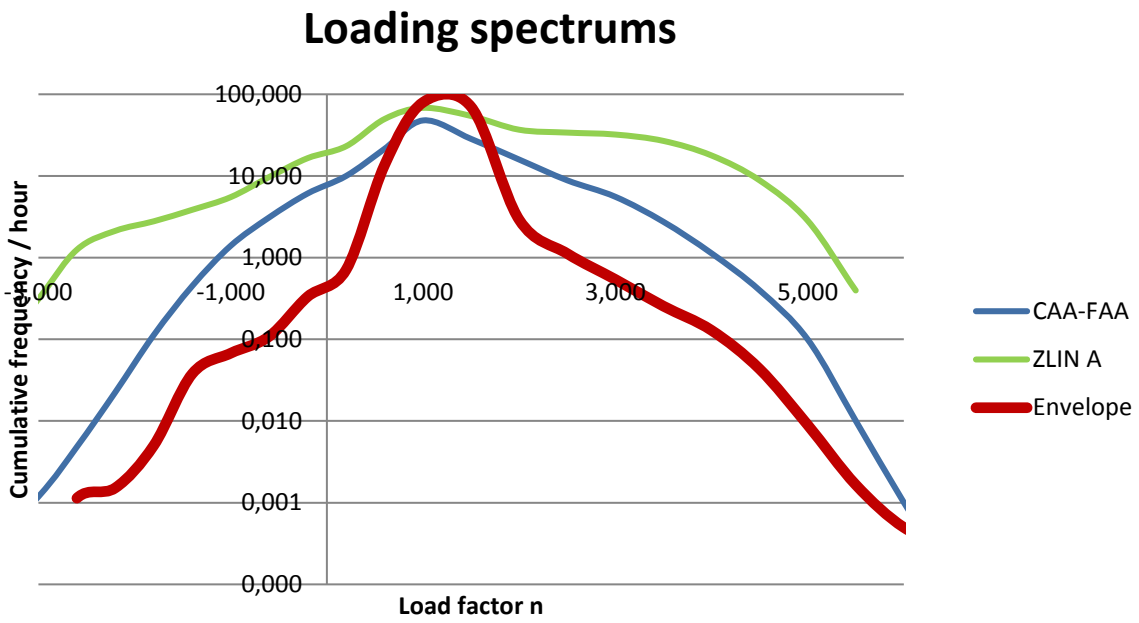
2.2 Considered spectrum of Z 242L aircraft loading

There are considered following manoeuvring loading spectrums in this report:

- **ZLIN-A** acrobatic spectrum, the loading spectrum was gained experimentally by means of accelerometer AMU1 - see the Z242L-0530 report.

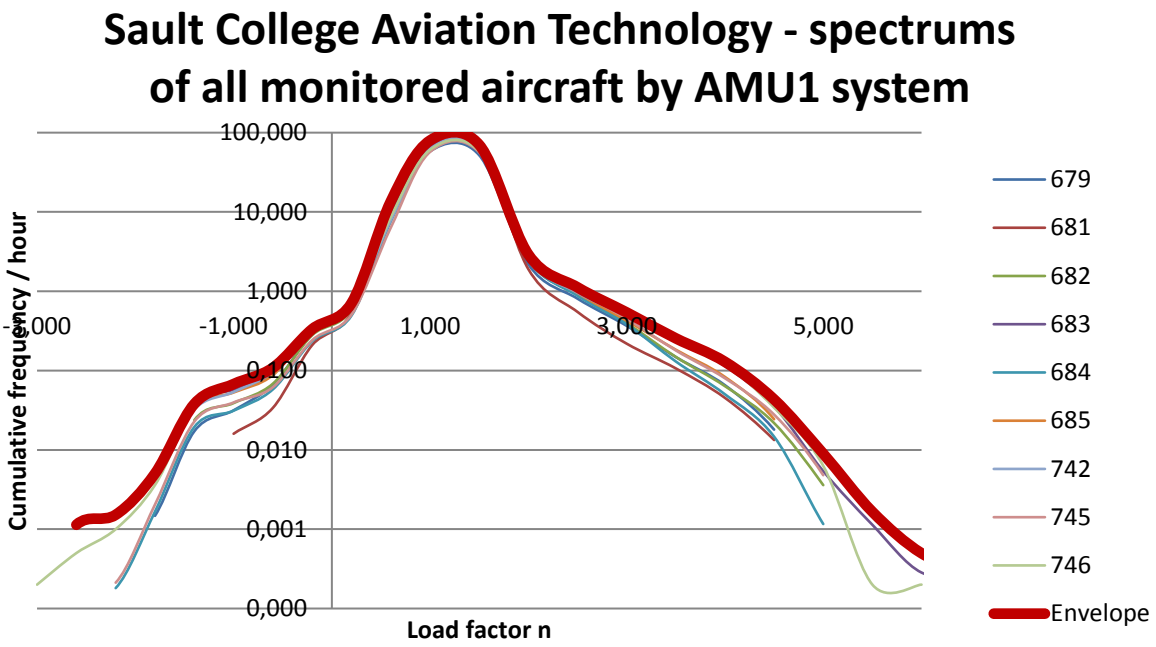
- **CAA-FAA** spectrum, the loading spectrum was gained after consultations between aviation authorities CAA and FAA for common acrobatic operation.

- **ENVELOPE** spectrum, the loading spectrum was gained as a safety envelope from all aircrafts operated by Sault College Aviation Technology. Monitored period is mentioned in the Table No. 1-1.



Load factor	Loading spectrums - Cumulative frequency/hour		
	CAA-FAA	ZLIN A	Envelope
-3.800	1.224E-04	1.866E-02	0.000E+00
-3.000	1.185E-03	3.112E-01	2.000E-04
-2.600	4.825E-03	1.250E+00	1.136E-03
-2.200	2.257E-02	2.128E+00	1.519E-03
-1.800	1.131E-01	2.786E+00	5.029E-03
-1.400	4.503E-01	3.855E+00	3.792E-02
-1.000	1.399E+00	5.508E+00	6.760E-02
-0.600	3.109E+00	9.705E+00	1.086E-01
-0.200	6.106E+00	1.652E+01	3.333E-01
0.200	1.000E+01	2.312E+01	7.101E-01
0.600	2.149E+01	4.977E+01	1.361E+01
1.000	4.786E+01	6.823E+01	7.974E+01
1.500	2.841E+01	5.420E+01	7.019E+01
2.000	1.586E+01	3.681E+01	2.907E+00
2.500	8.840E+00	3.396E+01	1.120E+00
3.000	5.562E+00	3.214E+01	5.407E-01
3.500	2.747E+00	2.685E+01	2.548E-01
4.000	1.131E+00	1.782E+01	1.289E-01
4.500	3.985E-01	8.831E+00	4.330E-02
5.000	9.996E-02	2.838E+00	8.958E-03
5.500	1.006E-02	3.963E-01	1.659E-03
6.000	1.006E-03	6.138E-02	4.977E-04
6.500	1.160E-04	0.000E+00	2.841E-04

Table 2-3 Considered spectrum of Z 242L aircraft loading



Load factor	Recorded spectrums by AMU1 system - Cumulative frequency/hour									Envelope
	679	681	682	683	684	685	742	745	746	
-3.800										0.000E+00
-3.000									0.000	2.000E-04
-2.600				0.001	0.000			0.000	0.001	1.136E-03
-2.200	0.000			0.002	0.000	0.001	0.000	0.000	0.001	1.519E-03
-1.800	0.001		0.002	0.005	0.002	0.005	0.005	0.002	0.004	5.029E-03
-1.400	0.017	0.007	0.024	0.038	0.019	0.035	0.032	0.023	0.033	3.792E-02
-1.000	0.032	0.016	0.039	0.058	0.031	0.053	0.054	0.040	0.068	6.760E-02
-0.600	0.067	0.034	0.068	0.091	0.058	0.088	0.097	0.062	0.109	1.086E-01
-0.200	0.287	0.210	0.280	0.316	0.235	0.332	0.333	0.242	0.331	3.333E-01
0.200	0.609	0.536	0.587	0.640	0.494	0.710	0.644	0.508	0.639	7.101E-01
0.600	9.586	13.609	8.610	10.548	7.605	12.610	7.878	6.363	8.652	1.361E+01
1.000	58.177	79.744	63.077	65.679	60.531	77.939	62.281	57.282	60.904	7.974E+01
1.500	51.805	67.377	59.812	58.104	58.128	70.192	59.938	56.236	57.879	7.019E+01
2.000	2.186	1.897	2.493	2.520	2.525	2.644	2.603	2.907	2.849	2.907E+00
2.500	0.807	0.549	0.918	0.983	0.877	0.948	0.958	1.014	1.120	1.120E+00
3.000	0.367	0.218	0.396	0.489	0.383	0.427	0.497	0.452	0.541	5.407E-01
3.500	0.148	0.107	0.149	0.233	0.130	0.183	0.255	0.179	0.237	2.548E-01
4.000	0.065	0.045	0.064	0.114	0.050	0.083	0.129	0.080	0.120	1.289E-01
4.500	0.018	0.013	0.022	0.035	0.015	0.024	0.043	0.028	0.034	4.330E-02
5.000	0.002	0.003	0.004	0.005	0.001	0.003	0.009	0.005	0.006	8.958E-03
5.500			0.000	0.001	0.000		0.002	0.000	0.000	1.659E-03
6.000				0.000			0.000		0.000	4.977E-04
6.500				0.000						2.841E-04

Table 2-4 Recorded spectrums by AMU1 system - Cumulative frequency/hour

3 SAFE FATIGUE LIFE OF THE Z 242L AIRCRAFT

The safe fatigue life calculation was performed according to AFS-120-73-2 and AC23-13A methodology.

Wing of the Z 242L aircraft was loaded by this loading spectrum:

- Manoeuvre + Gust: Envelope, (U, N category)
- Landing: Fig. No.:9 Curve for "Private Trainer", AFS-120-73-2, [2] or [3]
- Taxi: Fig. No.:10R Curve for "All Others (Rev)", AFS-120-73-2, [2] or [3]

The critical point of wings, drawing No. L242.2100/2200 of Z 242L aircraft from the fatigue life point of view is lower duralumin flange close behind the attachment fittings.

Loading at flight as well as at standing on the ground was taken over from the flight measurements of Z 242L aircraft OK-VNP, S/N 0490. Results of stress measurements for the wing of the Z 242L are mentioned in [3].

S-N curves were taken over:

- For duralumin flanges from FAA methodology AFS 120-73-2, [2].
- Fatigue test of main spar of the fuselage frame specimens - Report Z242L-0564, [3].

3.1 The fatigue test of the wing made based on ZLIN-A and ZLIN-N loading spectra

The results of the fatigue test are given in detail in the Z242L-0553 report, [4].

Conclusion:

The result value of Safe Fatigue Life of airframe of the Z 242L aircraft for the ZLIN-A and ZLIN-N manoeuvring spectra is 5500 flight hours, 700 acrobatic hours from it.

3.2 Results of fatigue tests of three main wing spars of the Z 242L aircraft at the CAA-FAA load spectrum

Fatigue tests of three main wing spars of the Z 242L aircraft were made. Results of fatigue tests are given in Report Z 242L-0520, [5].

Conclusion:

The result value of Safe Fatigue Life of airframe of the Z 242L aircraft for the CAA-FAA manoeuvring spectrum is 5500 flight hours without acrobatic limitation.

4 SAFE FATIGUE LIFE OF THE WING

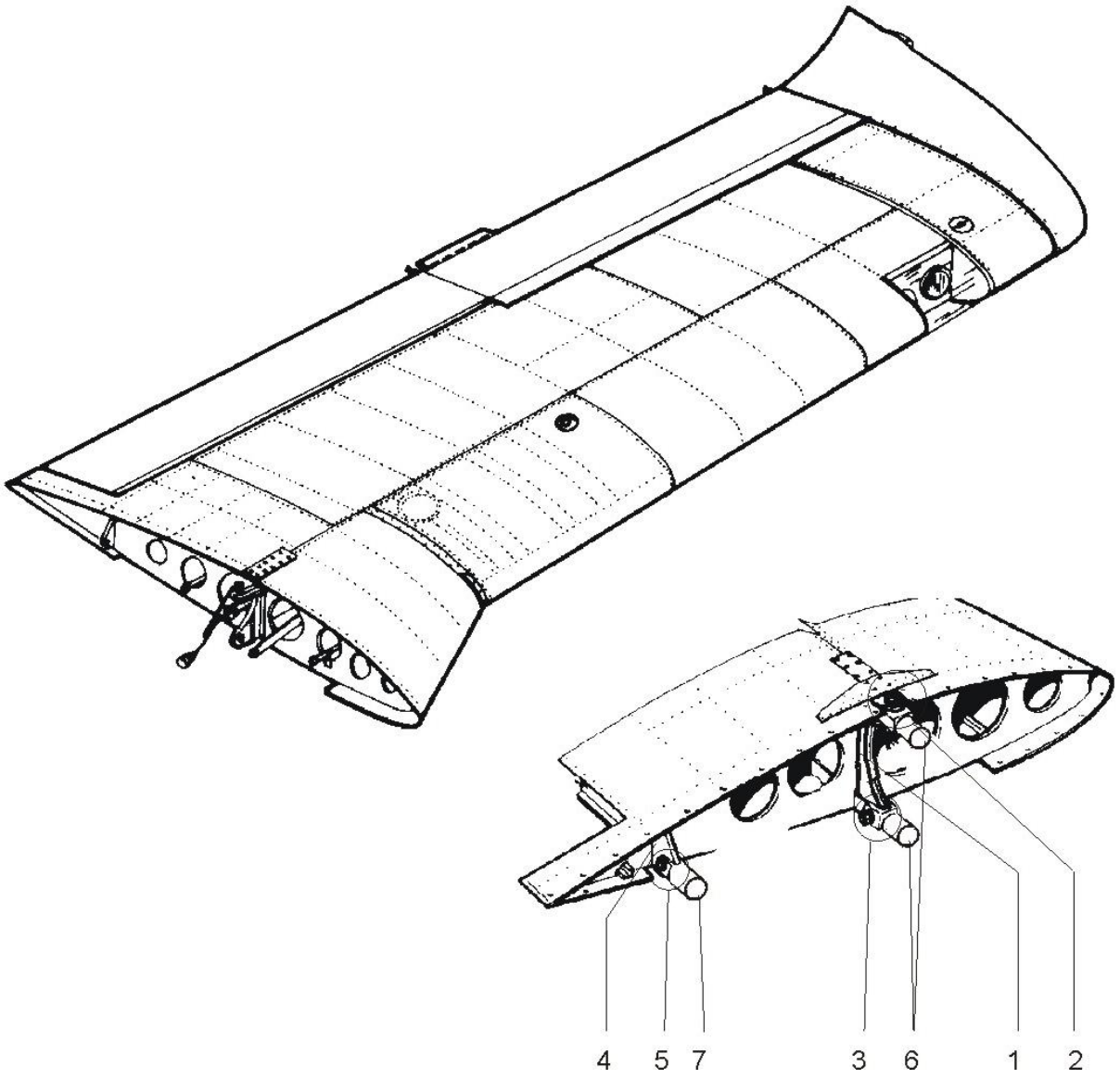


Fig. 4-1 Wing of the Z 242L aircraft

1 .... main wing spar
2 .... wing upper attachment fitting
3 .... wing lower attachment fitting
4 .... rear wing spar
5 .... rear wing attachment fitting
6 .... main spar of the fuselage frame
7 .... rear spar of the fuselage frame

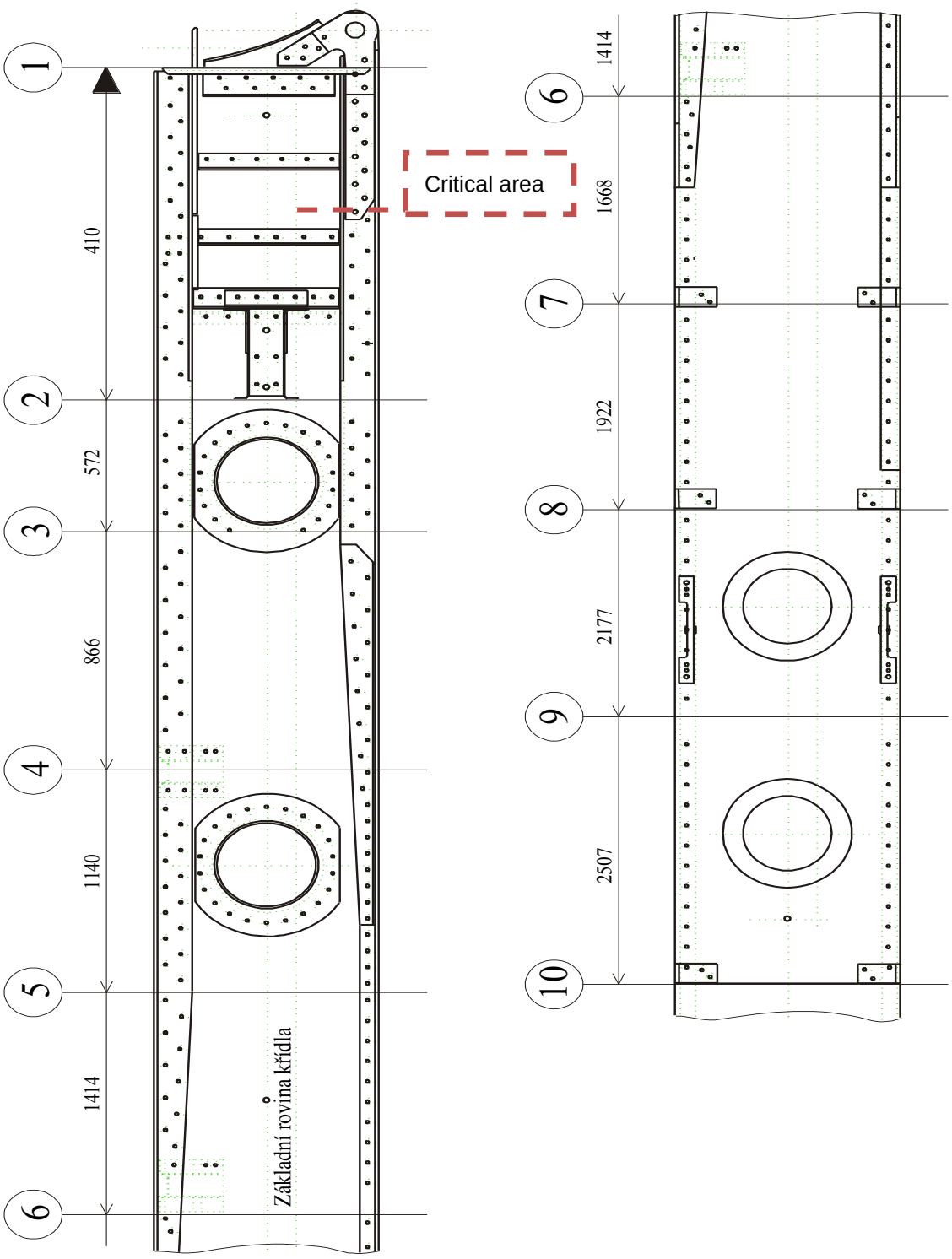


Fig. 4-2 Main wing spar of the Z 242L aircraft

4.1 Stress values in critical section A-A (Category U)

The loading conditions for UTILITY category are recalculated on the base of the maximum take-off weight, Report Z242-0564, [3]. The input values are presented lower:

Loading in flight:	n= 1.0 g	**σ_{+1g} = 24.90 MPa**	/flange margin/
Loading at the ground stay:	n= -1.0 g	**σ_{-1g} = -7.4 MPa**	/flange margin/

Phases of flight	Fatigue damage D_i [1 per flight hour]
Taxi	1.1712E-11
Gust and Manoeuvres	8.6250E-06
Landing – (Impact-Rebound)	1.3561E-08
G-A-G cycle	1.3878E-06
Total fatigue damage D_C	1.0026E-05

Table 4-2 U category operation; fatigue damage caused by ENVELOPE spectrum

$L_S = 1/D_C$ = 99 737 flight hours

4.2 Stress values in critical section A-A (Category N)

The loading conditions for NORMAL category are recalculated on the base of the maximum take-off weight, Report Z242-0564, [3]. The input values are presented lower:

Loading in flight:	n= +1.0 g	**σ_{+1g} = 26.63 MPa**	/flange margin/
Loading at the ground stay:	n= -1.0 g	**σ_{-1g} = -8.0 MPa**	/flange margin/

Phases of flight	Fatigue damage Di [1 per flight hour]
Taxi	1.5246E-11
Gust and Manoeuvres	5.9526E-06
Landing – (Impact-Rebound)	1.9071E-08
G-A-G cycle	1.8862E-06
Total fatigue damage D_C	7.8579E-06

Table 4-3 N category operation; fatigue damage caused by Zlin-N spectrum

$L_S = 1/D_C$ = 127 261 flight hours.

4.3 Safety factor determination

Based on the period of monitoring by AMU1 and results of wing fatigue tests, the safety factor is set to $j_N = 5.0$.

4.4 Safe fatigue life calculation for Canada-Operation loading spectrum

The Safe Fatigue Life of the wing is calculated according lower mentioned formula. For these purposes the Category U, N results are used for the safe fatigue life calculation.

$$L_B = L_S^{(Category\ U)} / j_N = 99\ 737 / 5 = 19\ 947 \text{ flight hours.}$$
$$L_B = L_S^{(Category\ N)} / j_N = 127\ 261 / 5 = 25\ 452 \text{ flight hours.}$$

Type	S/N	Reg. mark	Flight hrs. (8/2018)	Landings	Monitored by AMU1	Safe-life limit	Possible operation time	Possible total operation time
[-]	[-]	[-]	[Hrs]	[-]	[Hrs]	[%]	[Hrs]	[Hrs]
Z242L	745	C-GHXF	10391:24	9712	9983:30:00	66.48%	13 261	23 653
Z242L	746	C-GJOR	10899:30	10248	10393:50:00	59.49%	11 867	22 766

Table 4-4 Possible total operational life for Z 242L aircraft wing

Safe fatigue life determination of Z 242L aircraft wing

Conclusion:

Based on executed fatigue tests and calculations and with respect to other groups of airframe of the aircraft, we appoint the value of safe fatigue life for the wing of the Z 242L aircraft to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for aircraft Z 242L - Part I, II.

Replacement:

Conic pins and bushings for attaching the wings to the fuselage - after every 6000 flight hours.

5 SAFE FATIGUE LIFE OF MAIN SPAR OF THE FUSELAGE FRAME

The main spar of the fuselage frame is a complicated weldment that is made of steel tubes from L-CM3 material according to valid regulations and procedures. There are installed upper and lower attachments of the wing, attachments of the front seats and attachments of the main landing gear on the main spar of the fuselage frame. The lower flange of the main spar is equipped with pressure probe which signalises to the pilot contingent appearance of a crack on the flange.

Frame of the fuselage including main spar is shown on the Fig. 5-1.

Numbers of drawings and values of diameter and thickness of the upper and lower flange of the main spar of the fuselage frame for the Z 42 series are given in the Table 5-1.

Aircraft	Main spar	Upper flange		Lower flange	
	Drawing No.	Drawing No.	Tube ∅	Drawing No.	Tube ∅
Z42 to S/N 0059 including	Z42.1110	Z42.1111-00.17	Tube 55x3.0	Z42.1112-00.17	Tube 50x3
Z42 from 3rd series from S/N 0060	M42.1110	M42.1111-00.17	Tube 55x3.5	M42.1112-00.17	Tube 50x4
Z 142	M42.1110	M42.1111-00.17	Tube 55x3.5	M42.1112-00.17	Tube 50x4
Z 142C	M42.1110	M42.1111-00.17	Tube 55x3.5	M42.1112-00.17	Tube 50x4
Z 242L	**L242.1110**	**M42.1111-00.17**	**Tube 55x3.5**	**M42.1112-00.17**	**Tube 50x4**

Table 5-1 Drawings numbers and parameters of the upper and lower flange of the main spar of the fuselage frame

	C	Mn	Si	Cr	Mo		Ni	Cu	P	S
Chemical composition (%)	0.22 to 0.29	0.50 to 0.80	0.17 to 0.37	0.90 to 1.20	0.15 to 0.25		max. 0.30	max. 0.25	max. 0.030	max 0.030
Permitted deviations of chemical composition (%)	±0.01	±0.05	+0.05 -0.02	+0.10 -0.05	+0.07 -0.03					

Table 5-2 Chemical composition of L-CM3 material according to ONL 2100

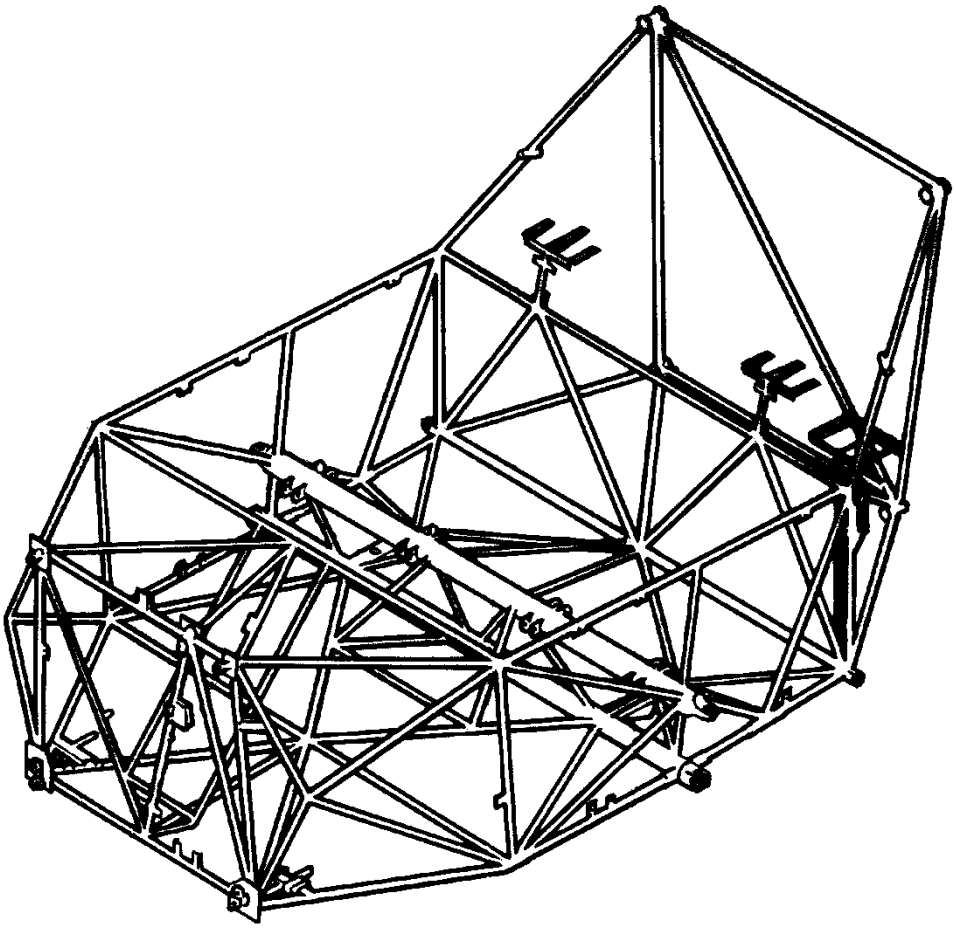


Fig. 5-1 Fuselage frame of the Z 242L aircraft

5.1 Stress values in critical section A-A (Category U)

The loading conditions for UTILITY Category are recalculated on the base of the maximum take-off weight, Report Z242-0564. The input values are presented lower:

Loading in flight: n= +1 g **σ_{+1g} = 57.9 MPa**
Loading at the ground stay: n= -1 g **σ_{-1g} = -2.2 MPa**

Phases of flight	Fatigue damage D_i [1 per flight hour]
Taxi	0.0000E+00
Gust and Manoeuvres	1.8959E-06
Landing – (Impact-Rebound)	3.6771E-09
G-A-G cycle	2.6881E-07
Total fatigue damage D_C	2.1684E-06

Table 5-5 U category operation; fatigue damage caused by ENVELOPE spectrum

$L_S = 1 / D_C$ = 461 180 flight hours.

5.2 Stress values in critical section A-A (Category N)

The loading conditions for NORMAL Category are recalculated on the base of the maximum take-off weight, Report Z242-0564. The input values are presented lower:

Loading in flight: n= +1 g **σ_{+1g} = 62.6 MPa**
Loading at the ground stay: n= -1 g **σ_{-1g} = -2.3 MPa**

Phases of flight	Fatigue damage D_i [1 per flight hour]
Taxi	0.0000E+00
Gust and Manoeuvres	1.7225E-06
Landing – (Impact-Rebound)	4.8278E-09
G-A-G cycle	3.4516E-07
Total fatigue damage D_C	2.0725E-06

Table 5-5 N category operation; fatigue damage caused by Zlin-N spectrum

$L_S = 1 / D_C$ = 482 507 flight hours.

5.3 Safety factor determination

According to AFS-20-73-2 methodology safety factor j_N = 7 - 8 is specified for Safe Fatigue Life calculation. Based on the origin of S-N curve (samples) and the mentioned methodology AC23-13A, it is recommended to choose value of j_N = 8.0 for standard cases.

5.4 Safe fatigue life calculation for ENVELOPE loading spectrum

The safe fatigue life of the fuselage frame is calculated according lower mentioned formula. For these purposes the Category U, N results are used for the safe fatigue life calculation.

$L_B = L_S^{(Category\ U)} / j_N$ = 461 180 / 8.0 = 57 647 flight hours.
$L_B = L_S^{(Category\ N)} / j_N$ = 482 507 / 8.0 = 60 313 flight hours.

5.5 Safe fatigue life determination of the fuselage frame main spar

Conclusion:

Based on executed calculation and with respect to other groups of airframe of the aircraft, we appoint the value of Safe Fatigue Life for the main spar of the fuselage frame to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for aircraft Z 242L - Part I, II.

System function check:

- Lower flange pressure following-up - every 500 flight hours or once a year.

Replacement of the pressure probe in system:

- Lower flange pressure following-up - after every 6000 flight hours.

6 SAFE FATIGUE LIFE OF THE REAR PART OF THE FUSELAGE AND BOLTS /Z42.1300-00.11/, CONNECTING CENTRAL AND REAR PART OF THE FUSELAGE

Fatigue life was appointed based on fatigue tests of fuselage rear part including connecting bolts – see Report Z242L-009, [6]. Conclusion of the fatigue tests analysis is given in Report Z242L-0564 Appendix No. 1, [3].

Rear part of the fuselage is shown on the Fig. 6-1 and connection of front and rear part of the fuselage is shown on the Fig. 6-1.

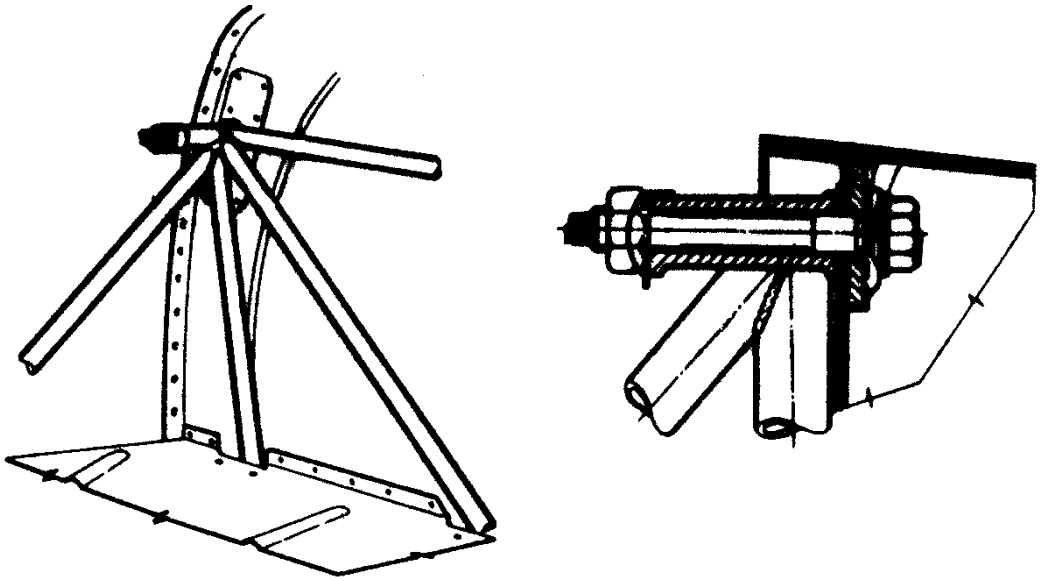


Fig. 6-1 Connection of fuselage front and rear part of the Z 242L aircraft

Conclusion:

We appoint the value of Safe Fatigue Life of bolts connecting central and rear part of the fuselage, with respect to present maintenance system to:

LB= 6 000 flight hours.

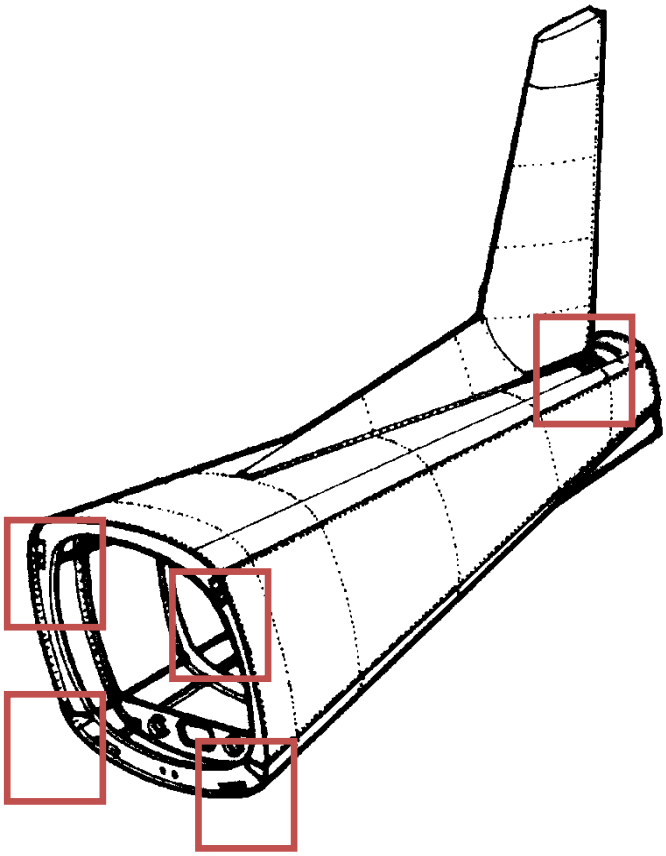


Fig. 6-2 Fuselage rear part of the Z 242L aircraft with market areas for visual inspection check

The Safe Fatigue Life of rear part of the fuselage will be secured with regular inspections and repairs in operation in accordance with specified maintenance system.

Conclusion:

We appoint the safe fatigue life value of rear part of the fuselage to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular inspections acc. to: Maintenance Manual Z 242L - Part I, II.

Replacement of the bolts connecting central and rear part of the fuselage:
- after every 6000 flight hours.

Visual inspection checks for crack, damage, deformation; see Fig. 6-2
- after every 500 flight hours.

7 SAFE FATIGUE LIFE OF TAIL SURFACES

Safe Fatigue Life of tail surfaces was specified neither by calculation, nor by test. Safe Fatigue Life of tail units will be secured by regular checks and contingent repairs in operation in accordance with specified maintenance system.

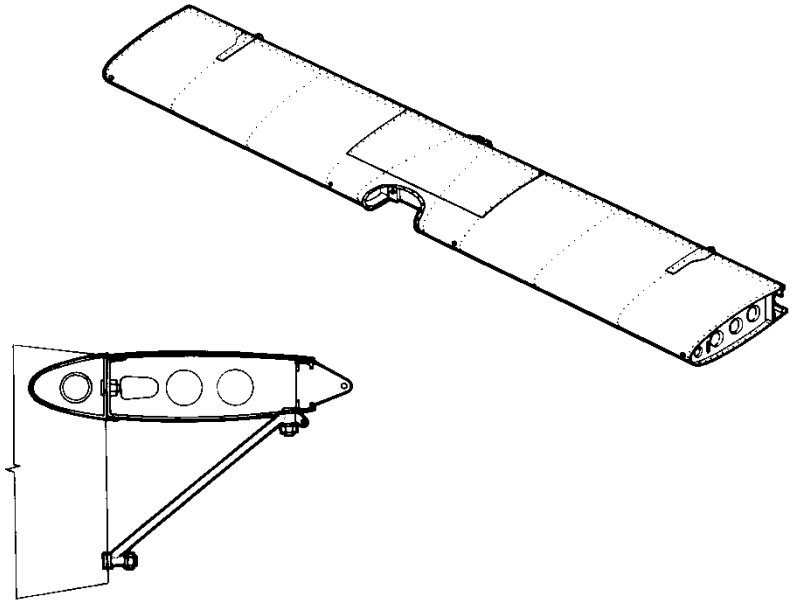


Fig. 7- 1 Stabilizer including supports

Conclusion:

We appoint the value of Safe Fatigue Life of tail surfaces according to the above-given and with respect to other groups of primary frame to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for Z 242L - Part I, II

Replacement:

- Stabilizer supports replacement including connecting bolts - after every 6000 flight hours.
- Connecting bolts attachment fittings of the stabilizer - after every 6000 flight hours.

8 SAFE FATIGUE LIFE OF ENGINE MOUNT

Safe Fatigue Life of engine mount was specified neither by calculation, nor by test. Safe Fatigue Life of engine mount will be secured by regular checks and repairs in operation in accordance with specified maintenance system.

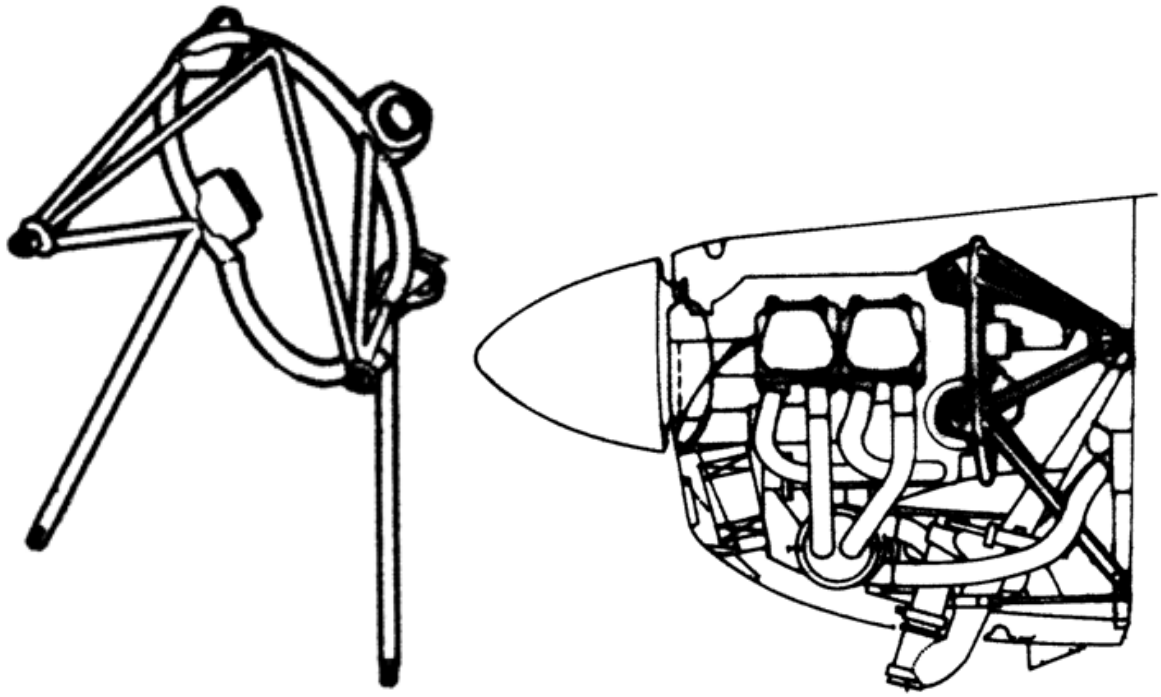


Fig. 8-1 Engine mount including engine clamping is shown on the

Conclusion:

We appoint the value of Safe Fatigue Life value of engine mount according to the above-given to:

LB= 6 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for aircraft Z 242L - Part I, II.

Replacement:

- Engine mount - after every 6000 flight hours.

9 REGULAR REPLACEMENTS OF PARTS OF THE Z 242L AIRCRAFT

• Main landing gear	2500 flight hours (11000 landings)
• Main landing gear hinges screw	2500 flight hours (11000 landings)
• Nose landing gear (without wheel)	3500 flight hours (15000 landings)

10 AIRCRAFT PARTS AT WHICH OVERHAUL IS MADE

• Engine	according to engine manufacturer data
• Engine aggregates	together with engine
• Magnetos	according to engine manufacturer data
• Propeller	according to propeller manufacturer data
• Propeller governor	according to governor manufacturer data
• Nose landing gear (without wheel)	according to manufacturer data

11 INSTRUMENTS AND AGGREGATES

Instruments and aggregates are kept “on condition”. Maintenance and checks are performed according to Maintenance Manual Z 242L - Part I, II.

12 OPERATION INFORMATION ANALYSIS

From the accessible information about the Z 242L aircraft operation in the aviation school (SCAT) results that there arose no significant failures of primary structure of the aircraft caused by operation loading of the aircraft. Increased number of defects was recorded at the brake system, propeller including propeller blades and flaps system.

13 CONCLUSION

The Z 242L aircraft is designed in the category A, U and N in according to FAR Part 23 - Amdt. 23-36 inclusive. The aircraft is intended for basic and advanced training or acrobatic training and practice.

Calculations and analyses of primary structure of Z 242L aircraft were executed in accordance with AFS-120-73-2 and AC23-13A methodologies and according to FAR 23 Amdt. 23-36 inclusive. The critical place from the fatigue life point of view is on the lower duralumin flange, close behind the attachments. Loading at flight as well as at standing on the ground was taken-over from flight measurements of the Z 242L aircraft. The S-N curves were taken-over for duralumin flanges from the FAA AFS-120-73-2 methodology, for the main spar of the fuselage frame from the fatigue test of Z 242L main spar of the fuselage frame specimens.

All SCAT aircrafts are monitored for the long time by the AMU1 system. The envelope of all AMU1 records was used as an input source for the aircraft prolongation.

From the calculations and fatigue tests follows that aircraft Z 242L, S/N 0745 and S/N 0746 operated in aviation school SCAT can be safely operated in category U and N up to 18 000 flight hours.

The Safe Fatigue Life value of the aircraft Z 242L, S/N 0745 and S/N 0746 primary structure is determined with respect to operation in SCAT to:

LB= 18 000 flight hours.

APPENDIX NO. 1

TECHNICAL COMMISSION REPORT BASED ON THE REQUEST TO INCREASE THE OPERATIONAL LIFE TIME UP TO 18 000 FLIGHT HOURS (S/N 0745)

ZLIN AIRCRAFT a.s.
Letiste 1887, 765 02 Otrokovice, Czech Republic
Design Organization Approval Certificate EASA.21J.110

Protocol from the aircraft inspection conducted by the Technical Commission

Protocol No. 25/2018	**Type: Z 242L**	**Owner: Sault College, Canada**

Registration mark	S/N	Year of production	TTSN	TLSN	TT from the last inspection	TL from the last inspection	Last Overhaul	
							Number of Rev. C	Date
C-GHXF	0745	2000	10 473,6	9 786	2 474	2 138	4	2015/2/03

Based on the service order from the owner of the aircraft, Technical Commission of aircraft Manufacturer - ZLIN AIRCRAFT a.s. Otrokovice - performed technical inspection of the airframe of the above specified aircraft.

After removing the failures stated in this Protocol, the Technical Commission recommended to:

☑ Technical Commission conducted technical inspection based on the request to increase the life time of the aircraft up to 18 000 flight hours.

Sault College, October 10, 2018

ZLIN AIRCRAFT a.s.
Technická komise
Letiště 1887
765 02 Otrokovice

Pavel Mužný
Technical Commission

No.	*Structural group and List of Failures - Concise description*
1.	**Fuselage L242.1000-00.00**
1.1	Sliding canopy – damaged rubber sealing on left side
2.	**Carrier system L242.0200-00.00**
	-OK
3.	**Empennage L242.3000-00.00**
	-OK
4.	**Control systems L242.4000-00.00**
4.1	Play in elevator control lever
4.2	Elevator trim – play in drum
5.	**Landing gear L242.5000-00.00**
	-OK
6.	**Engine installation L242.6000-00.00**
	-OK
7.	**Engine systems L242.7000-00.00**
	-OK

1

8.	**Cabin equipment L242.8100-00.00**
	-OK
9.	**Board equipment; Cabin ventilation and rating L242.8200-00.00, L242.8300-00.00**
9.1	Worn safety belts
10.	**Electrical system L242.8500-00.00**
10.1	Lock wire AMU fuse holder
10.2	Broken insolation of CHT transmitter conductor
11.	**Radio Equipment L242.8600-00.00**
	-OK
12.	**Electrical Lighting L242.8900-00.00**
	-OK

Main spar pressure – 240 kPa

A	**Failures which must be removed No.:**
	1.1, 4.1, 9.1, 10.1, 10.2
B	**Failures which are recommended to removed No.:**
	4.2
C	**Failures which hasn´t influence to airworthy No.:**
	N/A

The failures have been introduced to Mr. Rick Houle

OCT 10/18

APPENDIX NO. 2

TECHNICAL COMMISSION REPORT BASED ON THE REQUEST TO INCREASE THE OPERATIONAL LIFE TIME UP TO 18 000 FLIGHT HOURS (S/N 0746)

ZLIN AIRCRAFT a.s.
Letiste 1887, 765 02 Otrokovice, Czech Republic
Design Organization Approval Certificate EASA.21J.110

Protocol from the aircraft inspection conducted by the Technical Commission

Protocol No. 24/2018	**Type: Z 242L**	**Owner: Sault College, Canada**

Registration mark	S/N	Year of production	TTSN	TLSN	TT from the last inspection	TL from the last inspection	Last Overhaul	
							Number of Rev. C	Date
C-GJOR	0746	2001	10 983	10 320	983.3	899	5	2017/4/21

Based on the service order from the owner of the aircraft, Technical Commission of aircraft Manufacturer - ZLIN AIRCRAFT a.s. Otrokovice - performed technical inspection of the airframe of the above specified aircraft.

After removing the failures stated in this Protocol, the Technical Commission recommended to:

☑ Technical Commission conducted technical inspection based on the request to increase the life time of the aircraft up to 18 000 flight hours.

Sault College, October 9, 2018

ZLIN AIRCRAFT a.s.
Technická komise
Letiště 1887
765 02 Otrokovice

Pavel Mužný
Technical Commission

No.	*Structural group and List of Failures - Concise description*
1.	**Fuselage L242.1000-00.00**
1.1	Canopy emergency release – windows clean inside to inspect lock pins dirty
2.	**Carrier system L242.0200-00.00**
2.1	Measure L.H. wing aft pin clearance (pin 12,1)
2.2	L/H fuel tank cover – check „oil canning“
3.	**Empennage L242.3000-00.00**
3.1	Tighten lock washer on stab support strut nuts L/H side
3.2	Tighten hinge on elevator trim
4.	**Control systems L242.4000-00.00**
4.1	Clearance in right rudder control – left pull rod – rear joint
4.2	Adjustable pedals R/H chain tighten
4.3	R/H – small amount of clearance – check play in controls
4.4	Damaged cable of elevator trim tab
5.	**Landing gear L242.5000-00.00**
5.1	Left wheel brake disc – excess play
6.	**Engine installation L242.6000-00.00**

1

6.	**Engine installation L242.6000-00.00**
6.1	Exhaust center pin broken away from outer sheet
6.2	Engine driven pump damaged cooling shroud
6.3	Reposition clamp on L/H hose from no. 1 heat exchanger
7.	**Engine systems L242.7000-00.00**
7.1	Fuel leakage – drain-off valve of right wing tip tank
7.2	Shorten hose on drain from electric fuel pump so drain is all down hill
8.	**Cabin equipment L242.8100-00.00**
8.1	Damaged side safety belts L.H. + R.H.
9.	**Board equipment; Cabin ventilation and rating L242.8200-00.00, L242.8300-00.00**
	-OK
10.	**Electrical system L242.8500-00.00**
10.1	Lock wire AMU fuse holder
11.	**Radio Equipment L242.8600-00.00**
	-OK
12.	**Electrical Lighting L242.8900-00.00**
	-OK

Main spar pressure 240 kPa

A	**Failures which must be removed No.:**
	1.1, 3.1, 4.4, 5.1, 6.1, 6.2, 6.3, 7.1, 7.2, 8.1, 10.1
B	**Failures which are recommended to removed No.:**
	2.1, 2.2, 3.2, 4.1, 4.2, 4.3
C	**Failures which hasn´t influence to airworthy No.:**
	N/A

The failures have been introduced to Mr. Rick Houle ✓

OCT 10/18

2

LITERATURE

[1] Bělohradský, T.; Růžička, P.; Z 242L Assessment Report from point of view of the Safe Fatigue Life of 11 000 flight hours - Sault College Aviation Technology operation; 26. 9. 2003; Report Z242L-0554.

[2] Report No. AFS-120-73-2; Fatigue Evaluation of Wing and Associated Structure on Small Airplanes - FAA, May 1973.

[3] Bělohradský, T.; Carbol, V.; Totek, D.; Evaluation report for Z42 series aircrafts from the safe-life point of view 5500 flight hours and possible intensive aerobatics usage, aircrafts equipped by strengthened wings; 28. 11. 2007; Report Z242L-0564.

[4] Bělohradský, T.; Růžička, P.; Final report concerning evaluation of Z242L wing fatigue test; 30. 6. 2003; Report Z242L-0553.

[5] Bělohradský, T.; Definition of basic fatigue life for Z242L aircraft; October 1997; Report Z242L-0520.

[6] Fišer, J.; Safe fatigue life of the fuselage tail part and of the joint of the fuselage tail and middle parts; 29. 9. 1967; Report Z242L-009.

[7] Tománek, St.; Bělohradský, T; Z 242L Assessment Report - Aircraft Safe Life prolongation up to 18 000 flight hours Sault College Aviation Technology; 5. 4. 2011; Report Z242L-0567.

[8] Bělohradský, T; Z 242L Assessment Report - Aircraft Safe Life prolongation up to 18 000 flight hours Sault College Aviation Technology; 10.10. 2012; Report Z242L-0571.

[9] Bělohradský, T; Z 242L Assessment Report - Aircraft Safe Life prolongation up to 18 000 flight hours Sault College Aviation Technology; 01.06. 2014; Report Z242L-0572.

[10] Bělohradský, T; Z 242L Assessment Report - Aircraft Safe Life prolongation up to 18 000 flight hours Sault College Aviation Technology; 15.08. 2017; Report Z242L-0573.

MARKING USED

FAR Part 23		Federal Aviation Regulations for Small Airplanes, USA
AFS-120-73-2		FAA Fatigue Evaluation of Wing and Associated Structure on Small Airplanes
AC23-13A		FAA Advisory circular for fatigue analyses and tests
AMU1		Acceleration Monitoring Unit
SFL		Safe Fatigue Life
FAA		Federal Aviation Administration of the USA
CAA		Civil Aviation Authority of the Great Britain
ZLIN-A		Measured operating loading spectrum for acrobatic category
ZLIN-N		Measured operating loading spectrum for normal category
CAA-FAA		CAA operation acrobatic spectrum for the Z 40 series, modified FAA
ENVELOPE		Safe envelope of loading spectrum Canada-Operation
SCAT		Sault College Aviation Technology
S-N curve		Fatigue curve (Wöhler curve)
n	[-]	Load factor according to the FAR 23
σ_{+1g}	[MPa]	Stress in flight at n = +1(g)
σ_{-1g}	[MPa]	Stress at the ground stay n = -1(g)
D_i	[1/hod]	Fatigue damage in individual phases of flight
D_C	[1/hod]	Total fatigue damage
L_B	[hod]	Safe fatigue life value
L_S	[hod]	Mean fatigue life value
j_N	[-]	Scatter factor
V_P	[km/h]	Average airspeed

1 INTRODUCTION

The Sault College Aviation Technology (SCAT) operates a fleet of 11 ZLIN Z 242L aircraft. The list of aircraft is available in the Table No.1-1 bellow.

Type [-]	S/N [-]	Reg. mark [-]	Flight hrs. (09/2018) [Hrs]	Landings (09/2018) [-]	Monitored by AMU1 [Hrs]	Acro (A) [Hrs]	Acro (U) [Hrs]	Acro (A+U) [Hrs]	Safe-life limit [%]
Z 242L	0679	C-FQHT	12094:36	12089	5761:12:00	–	–	–	36.02 %
Z 242L	0681	C-FANU	14293:18	13701	5049:20:00	–	–	–	35.67 %
Z 242L	0682	C-FHTU	15690:48	15023	9583:55:00	–	–	–	27.20 %
Z 242L	0683	C-FVWH	Out of operation						
Z 242L	0684	C-FCSB	15790:12	15287	11475:24:00	–	–	–	23.78 %
Z 242L	0685	C-FVWT	14999:18	14305	10275:25:00	–	–	–	33.40 %
Z 242L	0699	C-FZHF	2490:06	2296	1890:30:00	–	–	53:54:00	74.33 %
Z 242L	0742	C-GHXG	11393:54	11400	10986:00:00	–	–	–	64.62 %
Z 242L	0743	C-GHXG	4893:06	4388	3711:55:00	–	–	126:00:00	77.22 %
Z 242L	0744	C-GERR	4498:30	4054	4252:35:00	–	–	–	80.15 %
Z 242L	0745	C-GHXF	10391:24	9712	9983:35:00	–	–	–	66.48 %
Z 242L	0746	C-GJOR	10899:30	10248	10393:55:00	–	–	–	59.49 %

Table No. 1-1 ZLIN Z 242L operated by Sault College Aviation Technology

The basic operational life of the Z 242L aircraft is 5500 flight hours. The aircraft are monitored by the acceleration monitoring unit AMU1. Based on the AMU1 monitoring a new operational limit has been set in the year 2003 by the Report No. Z242L-0554, [1]. The operational limit was increased from 5500 to 11000 flight hours.

At present days the aircraft Z 242L, S/N 0745 and S/N 0746 are reaching the operational limit 11000 flight hours. The aim of this assessment report is to prove Safe Fatigue Life (SFL) of aircraft primary structure up to 18000 flight hours for aircraft Z 242L, S/N 0745 and S/N 0746 operated in aviation school Sault College Aviation Technology in Canada. The long times monitoring by AMU1 system is used as an input source for the aircraft prolongation.

2 Z 242L AIRCRAFT

2.1 Brief description of the Z 242L aircraft

The Z 242L aircraft (Fig. 2-1) is designed in the category A, U and N according to FAR Part 23 - Amdt. 23-36 inclusive.

The Z 242L aircraft is intended for basic and advanced training, acrobatic training and practice, practice in night and instrument flying and glider towing.

The Z 242L aircraft is a two-seats, low-wing, single engine, self-supporting monoplane of all metal structure with side by side seats. The aircraft is equipped with nose-wheel tricycle fixed landing gear.

The aircraft is powered with the TEXTRON Lycoming AEIO-360-A1B6 piston air cooled flat 4-cylindre engine with the MTV-9-B-C/C-188-18a hydraulic controlled three-blade constant speed propeller. The engine is not equipped with reducer and is capable for acrobatics and inverted flights. The propeller is made of wood with composite covering. The propeller is capable for acrobatic manoeuvres.

Dimensions	
Span	9.340 m
Length	6.940 m
Height	2.950 m

Table 2-1 Basic dimensions of the Z 242L aircraft

Category	Cent. of gr. (% MAC)	Max. take-off weight (kg)	Max. landing weight (kg)	Max. range of permissible maneuvering load factors (g)
Acrobatic (A)	19.0 - 24.5	970	970	+6.0 ; -3.50
Utility (U)	19.0 - 24.5	1020	1020	+4.4 ; -1.76
Normal (N)	19.0 - 26.0	1090	1050	+3.8 ; -1.52

Table 2-2 Centre of gravity position, weight, manoeuvring load factors

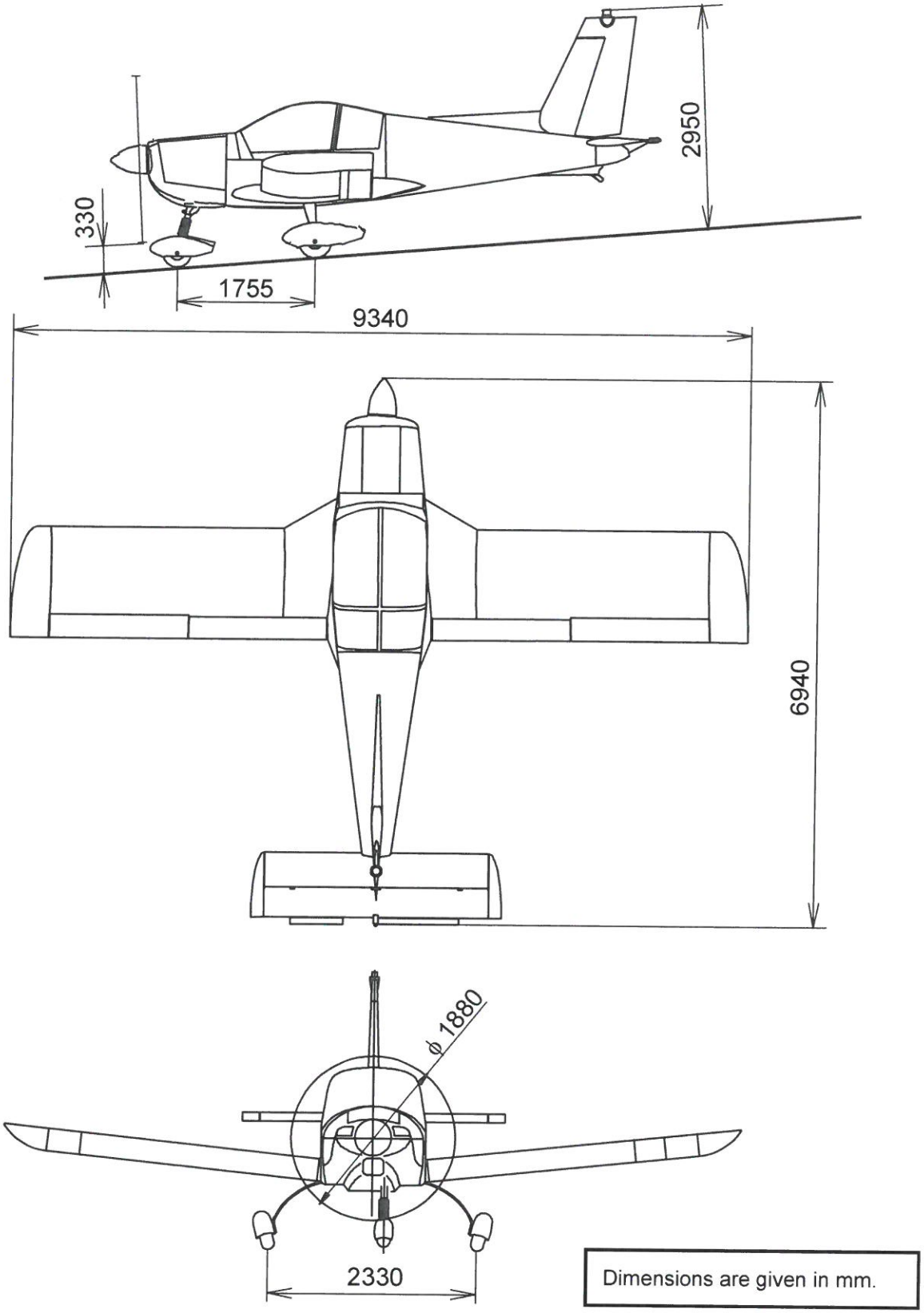


Fig. 2-1 Z 242L aircraft

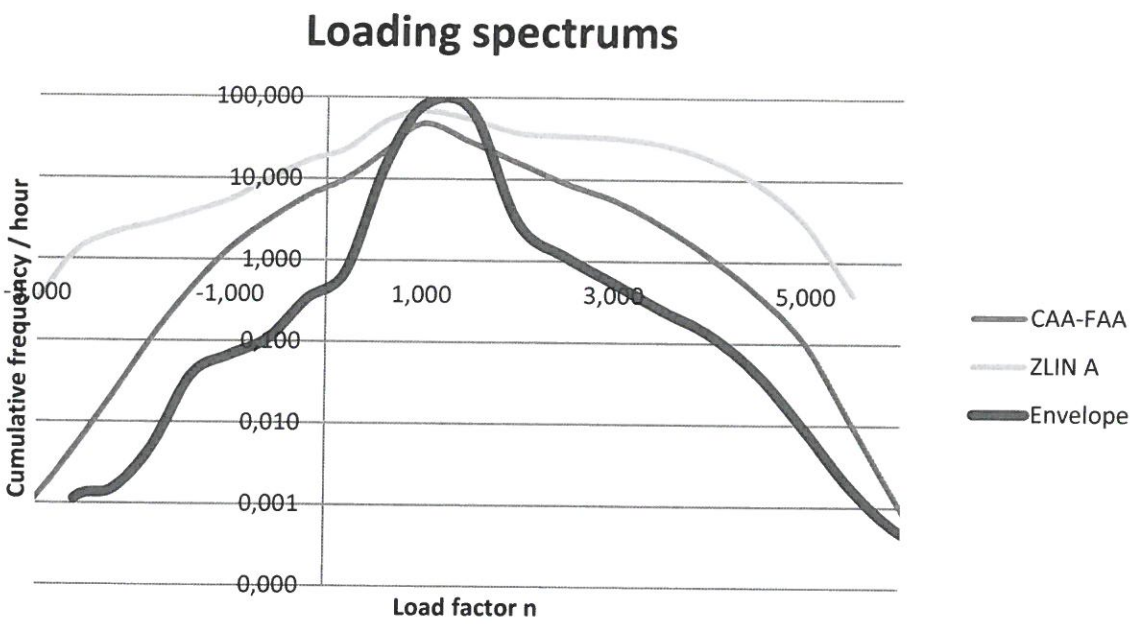
2.2 Considered spectrum of Z 242L aircraft loading

There are considered following manoeuvring loading spectrums in this report:

- **ZLIN-A** acrobatic spectrum, the loading spectrum was gained experimentally by means of accelerometer AMU1 - see the Z242L-0530 report.

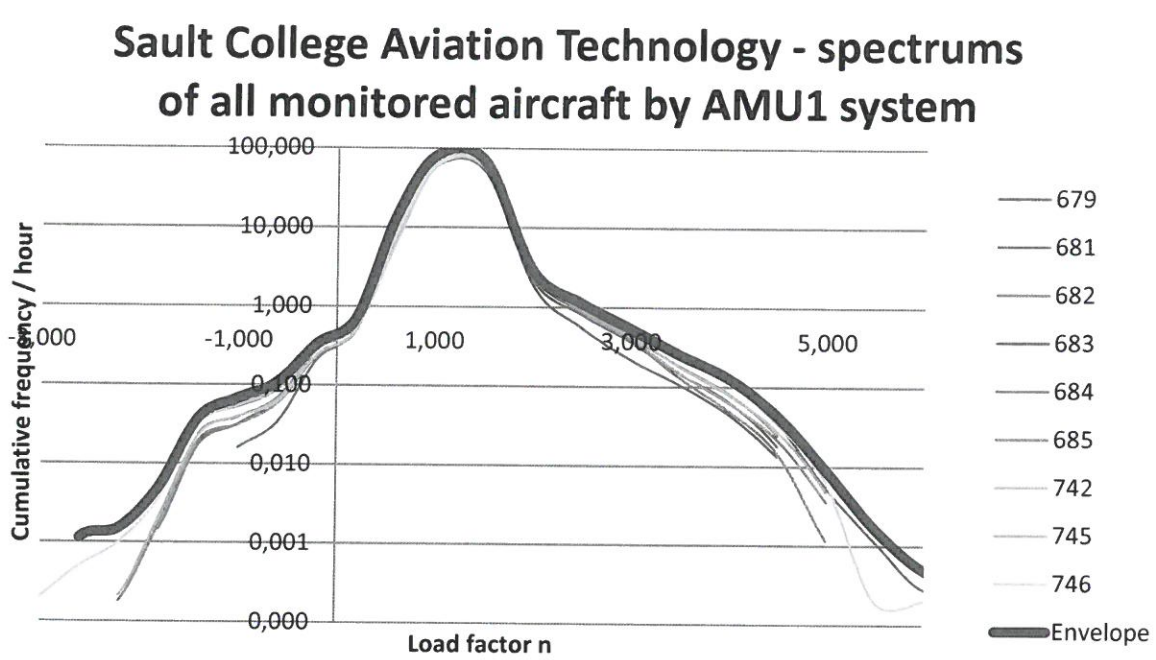
- **CAA-FAA** spectrum, the loading spectrum was gained after consultations between aviation authorities CAA and FAA for common acrobatic operation.

- **ENVELOPE** spectrum, the loading spectrum was gained as a safety envelope from all aircrafts operated by Sault College Aviation Technology. Monitored period is mentioned in the Table No. 1-1.



Load factor	Loading spectrums - Cumulative frequency/hour		
	CAA-FAA	ZLIN A	Envelope
-3.800	1.224E-04	1.866E-02	0.000E+00
-3.000	1.185E-03	3.112E-01	2.000E-04
-2.600	4.825E-03	1.250E+00	1.136E-03
-2.200	2.257E-02	2.128E+00	1.519E-03
-1.800	1.131E-01	2.786E+00	5.029E-03
-1.400	4.503E-01	3.855E+00	3.792E-02
-1.000	1.399E+00	5.508E+00	6.760E-02
-0.600	3.109E+00	9.705E+00	1.086E-01
-0.200	6.106E+00	1.652E+01	3.333E-01
0.200	1.000E+01	2.312E+01	7.101E-01
0.600	2.149E+01	4.977E+01	1.361E+01
1.000	4.786E+01	6.823E+01	7.974E+01
1.500	2.841E+01	5.420E+01	7.019E+01
2.000	1.586E+01	3.681E+01	2.907E+00
2.500	8.840E+00	3.396E+01	1.120E+00
3.000	5.562E+00	3.214E+01	5.407E-01
3.500	2.747E+00	2.685E+01	2.548E-01
4.000	1.131E+00	1.782E+01	1.289E-01
4.500	3.985E-01	8.831E+00	4.330E-02
5.000	9.996E-02	2.838E+00	8.958E-03
5.500	1.006E-02	3.963E-01	1.659E-03
6.000	1.006E-03	6.138E-02	4.977E-04
6.500	1.160E-04	0.000E+00	2.841E-04

Table 2-3 Considered spectrum of Z 242L aircraft loading



Load factor	Recorded spectrums by AMU1 system - Cumulative frequency/hour									
	679	681	682	683	684	685	742	745	746	Envelope
-3.800										0.000E+00
-3.000									0.000	2.000E-04
-2.600				0.001	0.000			0.000	0.001	1.136E-03
-2.200	0.000			0.002	0.000	0.001	0.000	0.000	0.001	1.519E-03
-1.800	0.001		0.002	0.005	0.002	0.005	0.005	0.002	0.004	5.029E-03
-1.400	0.017	0.007	0.024	0.038	0.019	0.035	0.032	0.023	0.033	3.792E-02
-1.000	0.032	0.016	0.039	0.058	0.031	0.053	0.054	0.040	0.068	6.760E-02
-0.600	0.067	0.034	0.068	0.091	0.058	0.088	0.097	0.062	0.109	1.086E-01
-0.200	0.287	0.210	0.280	0.316	0.235	0.332	0.333	0.242	0.331	3.333E-01
0.200	0.609	0.536	0.587	0.640	0.494	0.710	0.644	0.508	0.639	7.101E-01
0.600	9.586	13.609	8.610	10.548	7.605	12.610	7.878	6.363	8.652	1.361E+01
1.000	58.177	79.744	63.077	65.679	60.531	77.939	62.281	57.282	60.904	7.974E+01
1.500	51.805	67.377	59.812	58.104	58.128	70.192	59.938	56.236	57.879	7.019E+01
2.000	2.186	1.897	2.493	2.520	2.525	2.644	2.603	2.907	2.849	2.907E+00
2.500	0.807	0.549	0.918	0.983	0.877	0.948	0.958	1.014	1.120	1.120E+00
3.000	0.367	0.218	0.396	0.489	0.383	0.427	0.497	0.452	0.541	5.407E-01
3.500	0.148	0.107	0.149	0.233	0.130	0.183	0.255	0.179	0.237	2.548E-01
4.000	0.065	0.045	0.064	0.114	0.050	0.083	0.129	0.080	0.120	1.289E-01
4.500	0.018	0.013	0.022	0.035	0.015	0.024	0.043	0.028	0.034	4.330E-02
5.000	0.002	0.003	0.004	0.005	0.001	0.003	0.009	0.005	0.006	8.958E-03
5.500			0.000	0.001	0.000		0.002	0.000	0.000	1.659E-03
6.000				0.000			0.000		0.000	4.977E-04
6.500				0.000						2.841E-04

Table 2-4 Recorded spectrums by AMU1 system - Cumulative frequency/hour

3 SAFE FATIGUE LIFE OF THE Z 242L AIRCRAFT

The safe fatigue life calculation was performed according to AFS-120-73-2 and AC23-13A methodology.

Wing of the Z 242L aircraft was loaded by this loading spectrum:

- Manoeuvre + Gust: Envelope, (U, N category)
- Landing: Fig. No.:9 Curve for "Private Trainer", AFS-120-73-2, [2] or [3]
- Taxi: Fig. No.:10R Curve for "All Others (Rev)", AFS-120-73-2, [2] or [3]

The critical point of wings, drawing No. L242.2100/2200 of Z 242L aircraft from the fatigue life point of view is lower duralumin flange close behind the attachment fittings.

Loading at flight as well as at standing on the ground was taken over from the flight measurements of Z 242L aircraft OK-VNP, S/N 0490. Results of stress measurements for the wing of the Z 242L are mentioned in [3].

S-N curves were taken over:

- For duralumin flanges from FAA methodology AFS 120-73-2, [2].
- Fatigue test of main spar of the fuselage frame specimens - Report Z242L-0564, [3].

3.1 The fatigue test of the wing made based on ZLIN-A and ZLIN-N loading spectra

The results of the fatigue test are given in detail in the Z242L-0553 report, [4].

Conclusion:

The result value of Safe Fatigue Life of airframe of the Z 242L aircraft for the ZLIN-A and ZLIN-N manoeuvring spectra is 5500 flight hours, 700 acrobatic hours from it.

3.2 Results of fatigue tests of three main wing spars of the Z 242L aircraft at the CAA-FAA load spectrum

Fatigue tests of three main wing spars of the Z 242L aircraft were made. Results of fatigue tests are given in Report Z 242L-0520, [5].

Conclusion:

The result value of Safe Fatigue Life of airframe of the Z 242L aircraft for the CAA-FAA manoeuvring spectrum is 5500 flight hours without acrobatic limitation.

4 SAFE FATIGUE LIFE OF THE WING

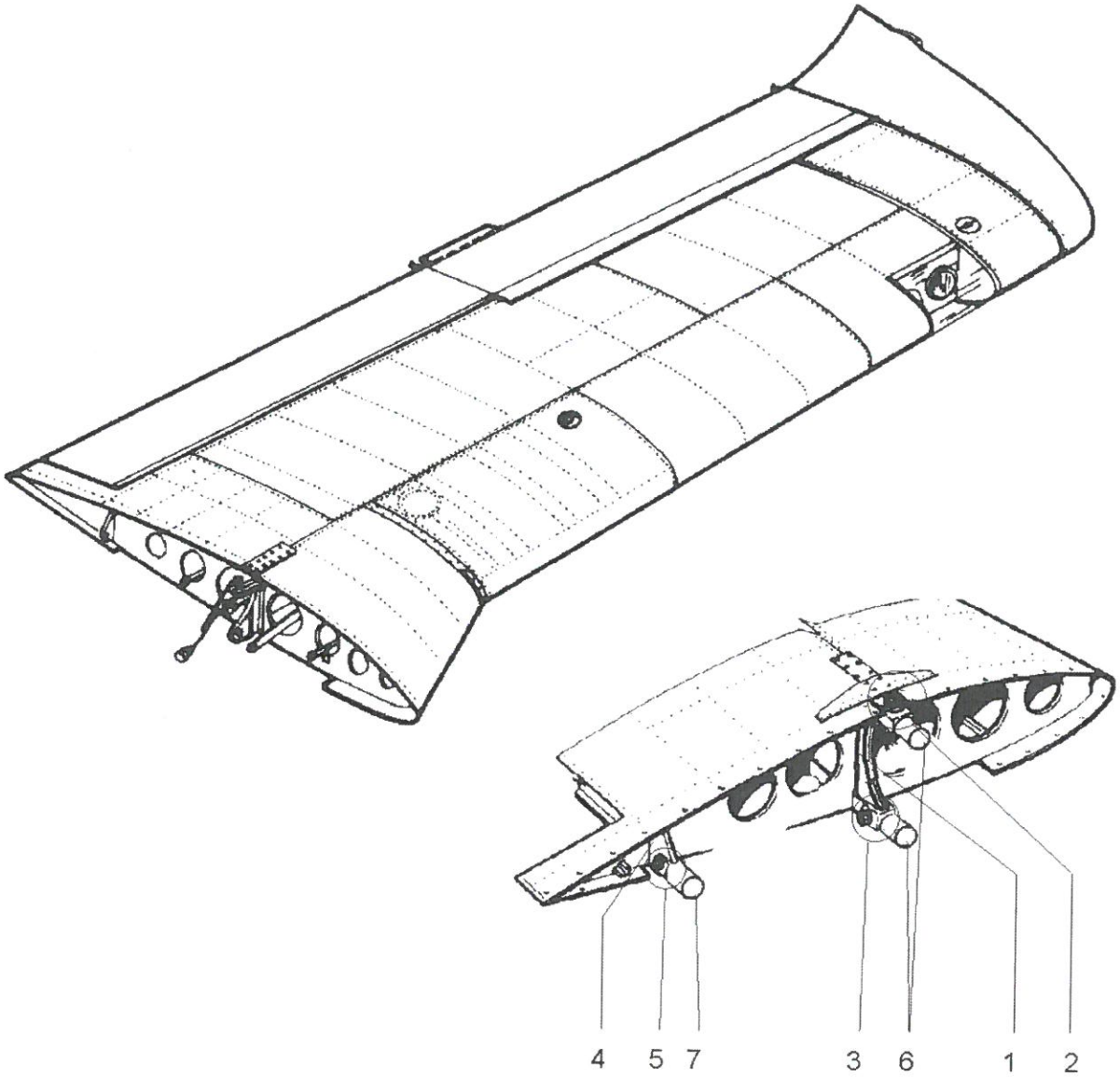


Fig. 4-1 Wing of the Z 242L aircraft

1 .... main wing spar
2 .... wing upper attachment fitting
3 .... wing lower attachment fitting
4 .... rear wing spar
5 .... rear wing attachment fitting
6 .... main spar of the fuselage frame
7 .... rear spar of the fuselage frame

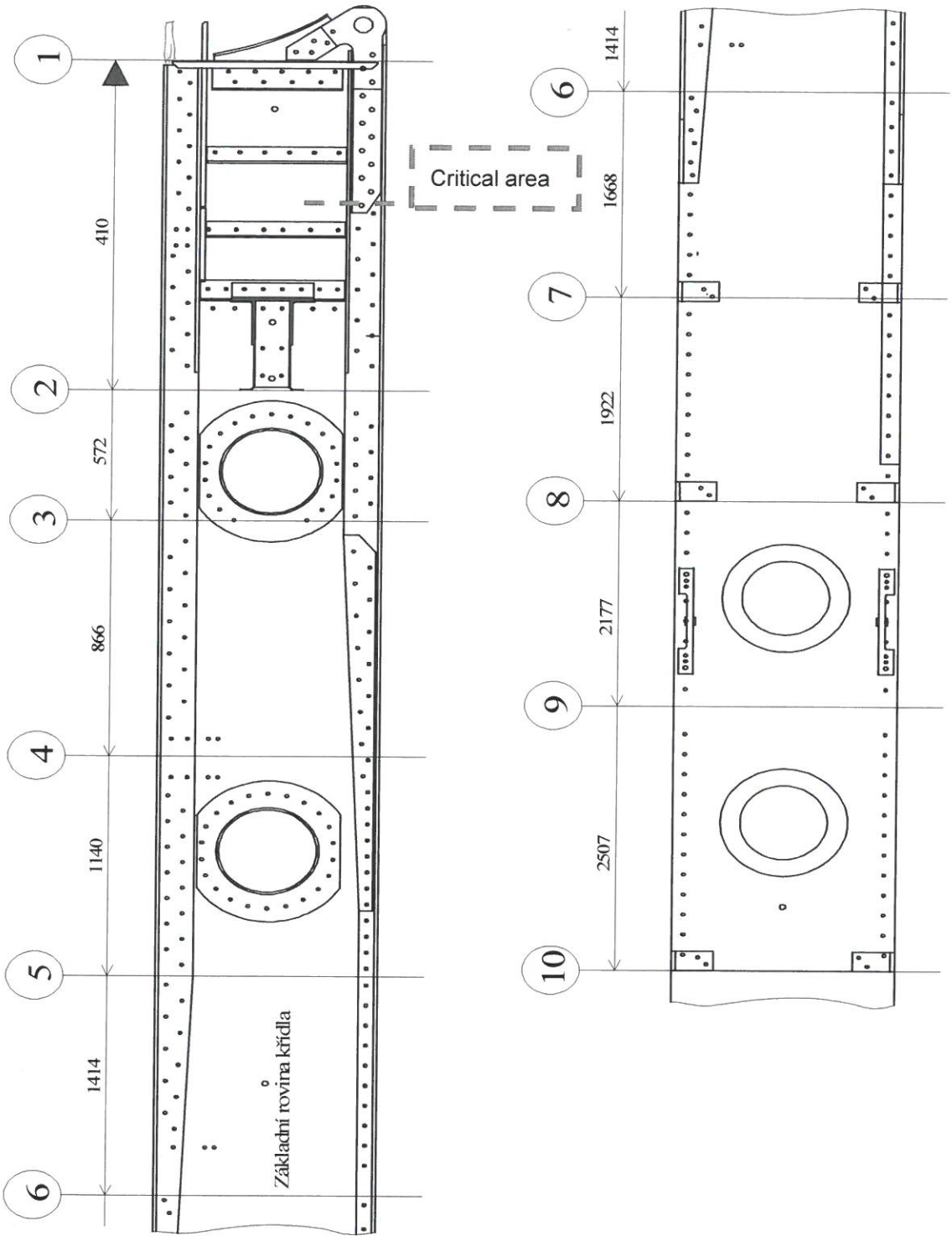


Fig. 4-2 Main wing spar of the Z 242L aircraft

4.1 Stress values in critical section A-A (Category U)

The loading conditions for UTILITY category are recalculated on the base of the maximum take-off weight, Report Z242-0564, [3]. The input values are presented lower:

Loading in flight:	n= 1.0 g	**σ_{+1g} = 24.90 MPa**	/flange margin/
Loading at the ground stay:	n= -1.0 g	**σ_{-1g} = -7.4 MPa**	/flange margin/

Phases of flight	Fatigue damage D_i [1 per flight hour]
Taxi	1.1712E-11
Gust and Manoeuvres	8.6250E-06
Landing – (Impact-Rebound)	1.3561E-08
G-A-G cycle	1.3878E-06
Total fatigue damage D_C	1.0026E-05

Table 4-2 U category operation; fatigue damage caused by ENVELOPE spectrum

$L_S = 1/D_C$ = 99 737 flight hours

4.2 Stress values in critical section A-A (Category N)

The loading conditions for NORMAL category are recalculated on the base of the maximum take-off weight, Report Z242-0564, [3]. The input values are presented lower:

Loading in flight:	n= +1.0 g	**σ_{+1g} = 26.63 MPa**	/flange margin/
Loading at the ground stay:	n= -1.0 g	**σ_{-1g} = -8.0 MPa**	/flange margin/

Phases of flight	Fatigue damage Di [1 per flight hour]
Taxi	1.5246E-11
Gust and Manoeuvres	5.9526E-06
Landing – (Impact-Rebound)	1.9071E-08
G-A-G cycle	1.8862E-06
Total fatigue damage D_C	7.8579E-06

Table 4-3 N category operation; fatigue damage caused by Zlin-N spectrum

$L_S = 1/D_C$ = 127 261 flight hours.

4.3 Safety factor determination

Based on the period of monitoring by AMU1 and results of wing fatigue tests, the safety factor is set to $j_N = 5.0$.

4.4 Safe fatigue life calculation for Canada-Operation loading spectrum

The Safe Fatigue Life of the wing is calculated according lower mentioned formula. For these purposes the Category U, N results are used for the safe fatigue life calculation.

$$L_B = L_S^{(Category\ U)} / j_N = 99\ 737 / 5 = 19\ 947 \text{ flight hours.}$$
$$L_B = L_S^{(Category\ N)} / j_N = 127\ 261 / 5 = 25\ 452 \text{ flight hours.}$$

Type	S/N	Reg. mark	Flight hrs. (8/2018)	Landings	Monitored by AMU1	Safe-life limit	Possible operation time	Possible total operation time
[-]	[-]	[-]	[Hrs]	[-]	[Hrs]	[%]	[Hrs]	[Hrs]
Z242L	745	C-GHXF	10391:24	9712	9983:30:00	66.48%	13 261	23 653
Z242L	746	C-GJOR	10899:30	10248	10393:50:00	59.49%	11 867	22 766

Table 4-4 Possible total operational life for Z 242L aircraft wing

Safe fatigue life determination of Z 242L aircraft wing

Conclusion:

Based on executed fatigue tests and calculations and with respect to other groups of airframe of the aircraft, we appoint the value of safe fatigue life for the wing of the Z 242L aircraft to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for aircraft Z 242L - Part I, II.

Replacement:

Conic pins and bushings for attaching the wings to the fuselage - after every 6000 flight hours.

5 SAFE FATIGUE LIFE OF MAIN SPAR OF THE FUSELAGE FRAME

The main spar of the fuselage frame is a complicated weldment that is made of steel tubes from L-CM3 material according to valid regulations and procedures. There are installed upper and lower attachments of the wing, attachments of the front seats and attachments of the main landing gear on the main spar of the fuselage frame. The lower flange of the main spar is equipped with pressure probe which signalises to the pilot contingent appearance of a crack on the flange.

Frame of the fuselage including main spar is shown on the Fig. 5-1.

Numbers of drawings and values of diameter and thickness of the upper and lower flange of the main spar of the fuselage frame for the Z 42 series are given in the Table 5-1.

Aircraft	Main spar	Upper flange		Lower flange	
	Drawing No.	Drawing No.	Tube ∅	Drawing No.	Tube ∅
Z42 to S/N 0059 including	Z42.1110	Z42.1111-00.17	Tube 55x3.0	Z42.1112-00.17	Tube 50x3
Z42 from 3rd series from S/N 0060	M42.1110	M42.1111-00.17	Tube 55x3.5	M42.1112-00.17	Tube 50x4
Z 142	M42.1110	M42.1111-00.17	Tube 55x3.5	M42.1112-00.17	Tube 50x4
Z 142C	M42.1110	M42.1111-00.17	Tube 55x3.5	M42.1112-00.17	Tube 50x4
Z 242L	**L242.1110**	**M42.1111-00.17**	**Tube 55x3.5**	**M42.1112-00.17**	**Tube 50x4**

Table 5-1 Drawings numbers and parameters of the upper and lower flange of the main spar of the fuselage frame

	C	Mn	Si	Cr	Mo		Ni	Cu	P	S
Chemical composition (%)	0.22 to 0.29	0.50 to 0.80	0.17 to 0.37	0.90 to 1.20	0.15 to 0.25		max. 0.30	max. 0.25	max. 0.030	max 0.030
Permitted deviations of chemical composition (%)	±0.01	±0.05	+0.05 -0.02	+0.10 -0.05	+0.07 -0.03					

Table 5-2 Chemical composition of L-CM3 material according to ONL 2100

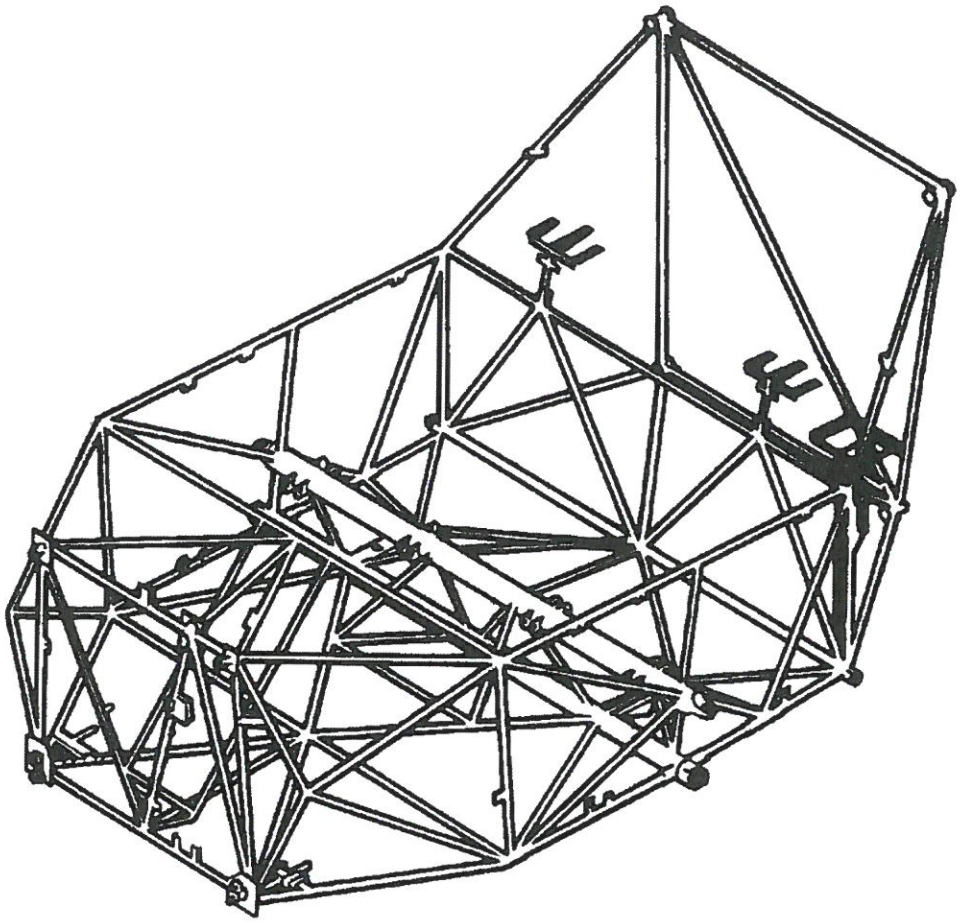


Fig. 5-1 Fuselage frame of the Z 242L aircraft

5.1 Stress values in critical section A-A (Category U)

The loading conditions for UTILITY Category are recalculated on the base of the maximum take-off weight, Report Z242-0564. The input values are presented lower:

Loading in flight: n= +1 g **σ_{+1g} = 57.9 MPa**
Loading at the ground stay: n= -1 g **σ_{-1g} = -2.2 MPa**

Phases of flight	Fatigue damage D_i [1 per flight hour]
Taxi	0.0000E+00
Gust and Manoeuvres	1.8959E-06
Landing – (Impact-Rebound)	3.6771E-09
G-A-G cycle	2.6881E-07
Total fatigue damage D_C	2.1684E-06

Table 5-5 U category operation; fatigue damage caused by ENVELOPE spectrum

$L_S = 1 / D_C$ = 461 180 flight hours.

5.2 Stress values in critical section A-A (Category N)

The loading conditions for NORMAL Category are recalculated on the base of the maximum take-off weight, Report Z242-0564. The input values are presented lower:

Loading in flight: n= +1 g **σ_{+1g} = 62.6 MPa**
Loading at the ground stay: n= -1 g **σ_{-1g} = -2.3 MPa**

Phases of flight	Fatigue damage D_i [1 per flight hour]
Taxi	0.0000E+00
Gust and Manoeuvres	1.7225E-06
Landing – (Impact-Rebound)	4.8278E-09
G-A-G cycle	3.4516E-07
Total fatigue damage D_C	2.0725E-06

Table 5-5 N category operation; fatigue damage caused by Zlin-N spectrum

$L_S = 1 / D_C$ = 482 507 flight hours.

5.3 Safety factor determination

According to AFS-20-73-2 methodology safety factor j_N = 7 - 8 is specified for Safe Fatigue Life calculation. Based on the origin of S-N curve (samples) and the mentioned methodology AC23-13A, it is recommended to choose value of j_N = 8.0 for standard cases.

5.4 Safe fatigue life calculation for ENVELOPE loading spectrum

The safe fatigue life of the fuselage frame is calculated according lower mentioned formula. For these purposes the Category U, N results are used for the safe fatigue life calculation.

$L_B = L_S^{(Category\ U)} / j_N$ = 461 180 / 8.0 = 57 647 flight hours.
$L_B = L_S^{(Category\ N)} / j_N$ = 482 507 / 8.0 = 60 313 flight hours.

5.5 Safe fatigue life determination of the fuselage frame main spar

Conclusion:

Based on executed calculation and with respect to other groups of airframe of the aircraft, we appoint the value of Safe Fatigue Life for the main spar of the fuselage frame to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for aircraft Z 242L - Part I, II.

System function check:

- Lower flange pressure following-up - every 500 flight hours or once a year.

Replacement of the pressure probe in system:

- Lower flange pressure following-up - after every 6000 flight hours.

6 SAFE FATIGUE LIFE OF THE REAR PART OF THE FUSELAGE AND BOLTS /Z42.1300-00.11/, CONNECTING CENTRAL AND REAR PART OF THE FUSELAGE

Fatigue life was appointed based on fatigue tests of fuselage rear part including connecting bolts – see Report Z242L-009, [6]. Conclusion of the fatigue tests analysis is given in Report Z242L-0564 Appendix No. 1, [3].

Rear part of the fuselage is shown on the Fig. 6-1 and connection of front and rear part of the fuselage is shown on the Fig. 6-1.

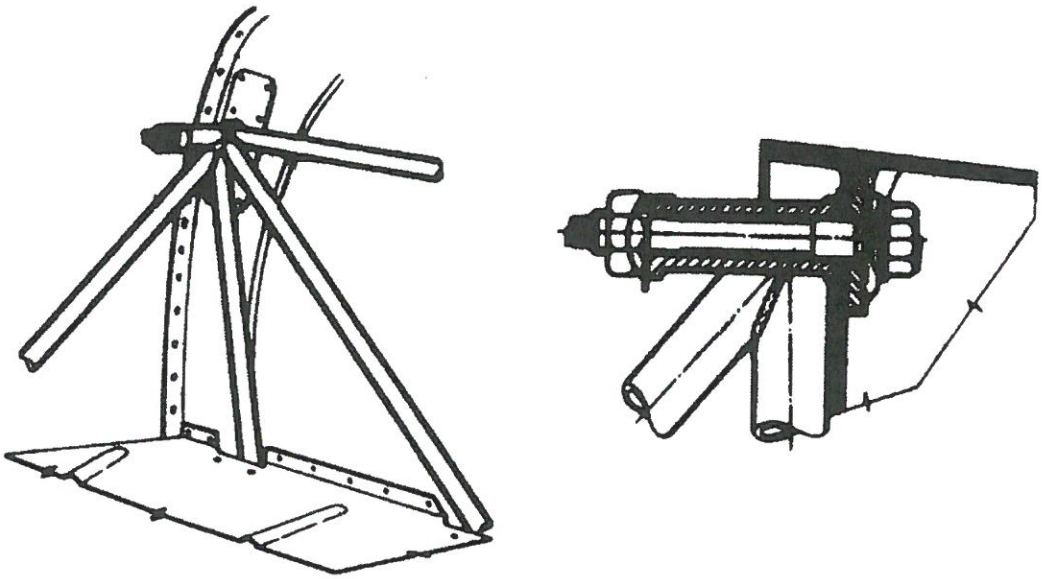


Fig. 6-1 Connection of fuselage front and rear part of the Z 242L aircraft

Conclusion:

We appoint the value of Safe Fatigue Life of bolts connecting central and rear part of the fuselage, with respect to present maintenance system to:

LB= 6 000 flight hours.

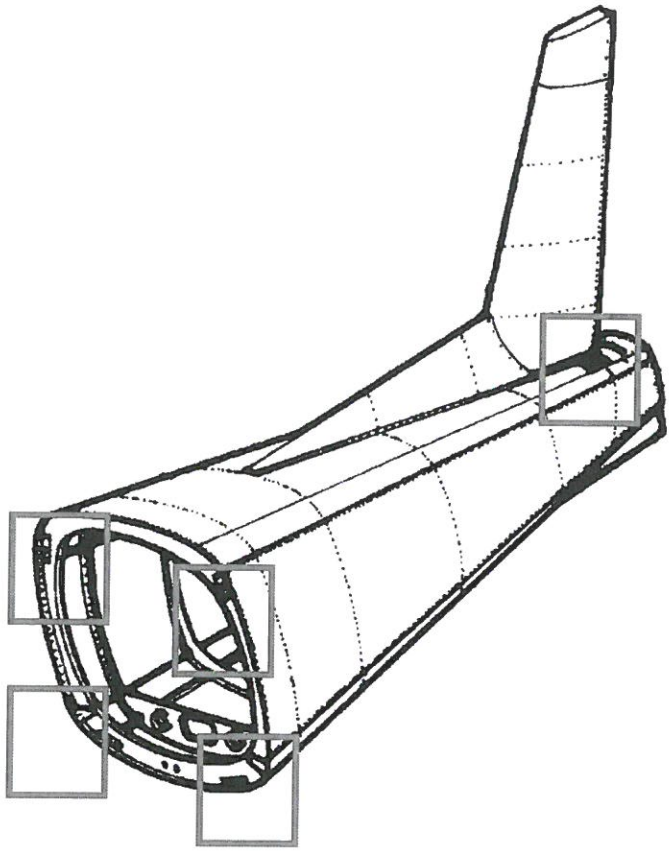


Fig. 6-2 Fuselage rear part of the Z 242L aircraft with market areas for visual inspection check

The Safe Fatigue Life of rear part of the fuselage will be secured with regular inspections and repairs in operation in accordance with specified maintenance system.

Conclusion:

We appoint the safe fatigue life value of rear part of the fuselage to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular inspections acc. to: Maintenance Manual Z 242L - Part I, II.

Replacement of the bolts connecting central and rear part of the fuselage:
- after every 6000 flight hours.

Visual inspection checks for crack, damage, deformation; see Fig. 6-2
- after every 500 flight hours.

7 SAFE FATIGUE LIFE OF TAIL SURFACES

Safe Fatigue Life of tail surfaces was specified neither by calculation, nor by test. Safe Fatigue Life of tail units will be secured by regular checks and contingent repairs in operation in accordance with specified maintenance system.

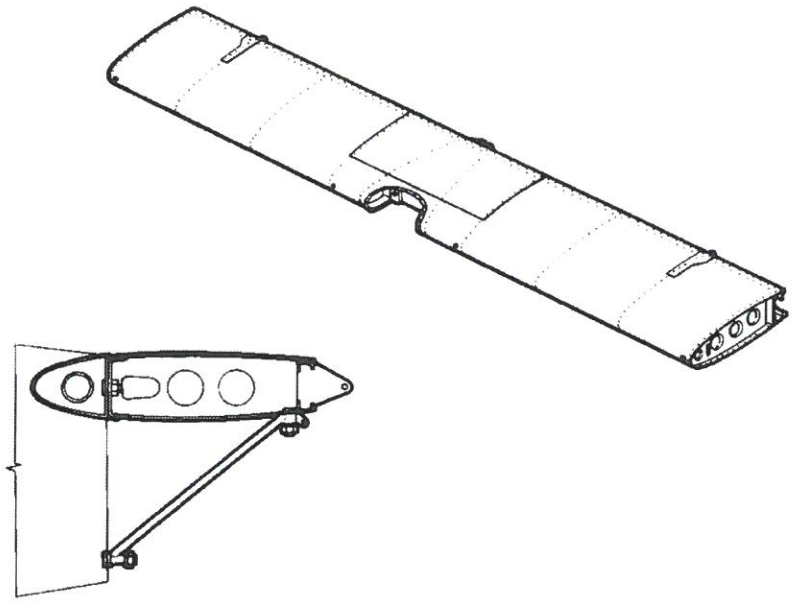


Fig. 7- 1 Stabilizer including supports

Conclusion:

We appoint the value of Safe Fatigue Life of tail surfaces according to the above-given and with respect to other groups of primary frame to:

LB= 18 000 flight hours.

Other procedures:

Proposed regular checks according to: Maintenance Manual for Z 242L - Part I, II

Replacement:

- Stabilizer supports replacement including connecting bolts - after every 6000 flight hours.
- Connecting bolts attachment fittings of the stabilizer - after every 6000 flight hours.

8 SAFE FATIGUE LIFE OF ENGINE MOUNT

Safe Fatigue Life of engine mount was specified neither by calculation, nor by test. Safe Fatigue Life of engine mount will be secured by regular checks and repairs in operation in accordance with specified maintenance system.

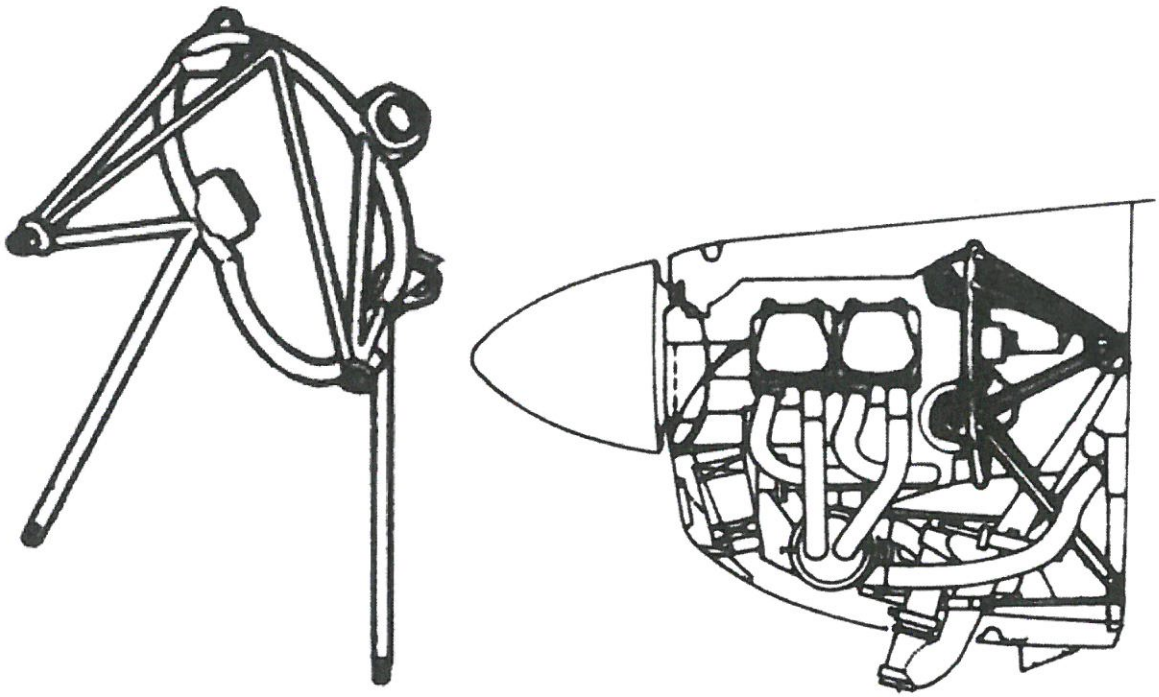


Fig. 8-1 Engine mount including engine clamping is shown on the

Conclusion:

We appoint the value of Safe Fatigue Life value of engine mount according to the above-given to:

LB= 6 000 flight hours.

Other procedures:

Proposed regular checks according to:	Maintenance Manual for aircraft Z 242L - Part I, II.
Replacement:	
• Engine mount	- after every 6000 flight hours.

9 REGULAR REPLACEMENTS OF PARTS OF THE Z 242L AIRCRAFT

• Main landing gear	2500 flight hours (11000 landings)
• Main landing gear hinges screw	2500 flight hours (11000 landings)
• Nose landing gear (without wheel)	3500 flight hours (15000 landings)

10 AIRCRAFT PARTS AT WHICH OVERHAUL IS MADE

• Engine	according to engine manufacturer data
• Engine aggregates	together with engine
• Magnetos	according to engine manufacturer data
• Propeller	according to propeller manufacturer data
• Propeller governor	according to governor manufacturer data
• Nose landing gear (without wheel)	according to manufacturer data

11 INSTRUMENTS AND AGGREGATES

Instruments and aggregates are kept "on condition". Maintenance and checks are performed according to Maintenance Manual Z 242L - Part I, II.

12 OPERATION INFORMATION ANALYSIS

From the accessible information about the Z 242L aircraft operation in the aviation school (SCAT) results that there arose no significant failures of primary structure of the aircraft caused by operation loading of the aircraft. Increased number of defects was recorded at the brake system, propeller including propeller blades and flaps system.

13 CONCLUSION

The Z 242L aircraft is designed in the category A, U and N in according to FAR Part 23 - Amdt. 23-36 inclusive. The aircraft is intended for basic and advanced training or acrobatic training and practice.

Calculations and analyses of primary structure of Z 242L aircraft were executed in accordance with AFS-120-73-2 and AC23-13A methodologies and according to FAR 23 Amdt. 23-36 inclusive. The critical place from the fatigue life point of view is on the lower duralumin flange, close behind the attachments. Loading at flight as well as at standing on the ground was taken-over from flight measurements of the Z 242L aircraft. The S-N curves were taken-over for duralumin flanges from the FAA AFS-120-73-2 methodology, for the main spar of the fuselage frame from the fatigue test of Z 242L main spar of the fuselage frame specimens.

All SCAT aircrafts are monitored for the long time by the AMU1 system. The envelope of all AMU1 records was used as an input source for the aircraft prolongation.

From the calculations and fatigue tests follows that aircraft Z 242L, S/N 0745 and S/N 0746 operated in aviation school SCAT can be safely operated in category U and N up to 18 000 flight hours.

The Safe Fatigue Life value of the aircraft Z 242L, S/N 0745 and S/N 0746 primary structure is determined with respect to operation in SCAT to:

LB= 18 000 flight hours.

APPENDIX NO. 1

TECHNICAL COMMISSION REPORT BASED ON THE REQUEST TO INCREASE THE OPERATIONAL LIFE TIME UP TO 18 000 FLIGHT HOURS (S/N 0745)

ZLIN AIRCRAFT a.s. Letiste 1887, 765 02 Otrokovice, Czech Republic Design Organization Approval Certificate EASA.21J.110								
Protocol from the aircraft inspection conducted by the Technical Commission								
Protocol No. 25/2018		**Type: Z 242L**			**Owner: Sault College, Canada**			
Registration mark	**S/N**	**Year of production**	**TTSN**	**TLSN**	**TT from the last inspection**	**TL from the last inspection**	**Last Overhaul**	
							Number of Rev. C	**Date**
C-GHXF	0745	2000	10 473,6	9 786	2 474	2 138	4	2015/2/03

Based on the service order from the owner of the aircraft, Technical Commission of aircraft Manufacturer - ZLIN AIRCRAFT a.s. Otrokovice - performed technical inspection of the airframe of the above specified aircraft.

After removing the failures stated in this Protocol, the Technical Commission recommended to:

☑ Technical Commission conducted technical inspection based on the request to increase the life time of the aircraft up to 18 000 flight hours.

Recommended restrictions: The aircraft must be operated in **NORMAL** category only.

Sault College, October 10, 2018

ZLIN AIRCRAFT a.s.
Technická komise
Letiště 1887
765 02 Otrokovice

Pavel Mužný
Technical Commission

No.	*Structural group and List of Failures - Concise description*
1.	**Fuselage L242.1000-00.00**
1.1	Sliding canopy - damaged rubber sealing on left side
2.	**Carrier system L242.0200-00.00**
	-OK
3.	**Empennage L242.3000-00.00**
	-OK
4.	**Control systems L242.4000-00.00**
4.1	Play in elevator control lever
4.2	Elevator trim - play in drum
5.	**Landing gear L242.5000-00.00**
	-OK
6.	**Engine installation L242.6000-00.00**
	-OK
7.	**Engine systems L242.7000-00.00**
	-OK

1

8.	**Cabin equipment L242.8100-00.00**
	-OK
9.	**Board equipment; Cabin ventilation and rating L242.8200-00.00, L242.8300-00.00**
9.1	Worn safety belts
10.	**Electrical system L242.8500-00.00**
10.1	Lock wire AMU fuse holder
10.2	Broken insolation of CHT transmitter conductor
11.	**Radio Equipment L242.8600-00.00**
	-OK
12.	**Electrical Lighting L242.8900-00.00**
	-OK

Main spar pressure – 240 kPa

A	**Failures which must be removed No.:**
	1.1, 4.1, 9.1, 10.1, 10.2
B	**Failures which are recommended to removed No.:**
	4.2
C	**Failures which hasn't influence to airworthy No.:**
	N/A

The failures have been introduced to Mr. Rick Houle ✓ 10/18

CCT 10/18

APPENDIX NO. 2

TECHNICAL COMMISSION REPORT BASED ON THE REQUEST TO INCREASE THE OPERATIONAL LIFE TIME UP TO 18 000 FLIGHT HOURS

(S/N 0746)

ZLIN AIRCRAFT a.s. Letiste 1887, 765 02 Otrokovice, Czech Republic Design Organization Approval Certificate EASA.21J.110								
Protocol from the aircraft inspection conducted by the Technical Commission								
Protocol No. 24/2018		**Type: Z 242L**			**Owner: Sault College, Canada**			
Registration mark	**S/N**	**Year of production**	**TTSN**	**TLSN**	**TT from the last inspection**	**TL from the last inspection**	**Last Overhaul**	
							Number of Rev. C	**Date**
C-GJOR	0746	2001	10 983	10 320	983.3	899	5	2017/4/21

Based on the service order from the owner of the aircraft, Technical Commission of aircraft Manufacturer - ZLIN AIRCRAFT a.s. Otrokovice - performed technical inspection of the airframe of the above specified aircraft.

After removing the failures stated in this Protocol, the Technical Commission recommended to:

☑ Technical Commission conducted technical inspection based on the request to increase the life time of the aircraft up to 18 000 flight hours.

Recommended restrictions: The aircraft must be operated in **NORMAL** category only.

Sault College, October 9, 2018

ZLIN AIRCRAFT a.s.
Technická komise
Letiště 1887
765 02 Otrokovice

Pavel Mužný
Technical Commission

No.	*Structural group and List of Failures - Concise description*
1.	**Fuselage L242.1000-00.00**
1.1	Canopy emergency release – windows clean inside to inspect lock pins dirty
2.	**Carrier system L242.0200-00.00**
2.1	Measure L.H. wing aft pin clearance (pin 12,1)
2.2	L/H fuel tank cover – check „oil canning"
3.	**Empennage L242.3000-00.00**
3.1	Tighten lock washer on stab support strut nuts L/H side
3.2	Tighten hinge on elevator trim
4.	**Control systems L242.4000-00.00**
4.1	Clearance in right rudder control – left pull rod – rear joint
4.2	Adjustable pedals R/H chain tighten
4.3	R/H – small amount of clearance – check play in controls
4.4	Damaged cable of elevator trim tab
5.	**Landing gear L242.5000-00.00**
5.1	Left wheel brake disc – excess play

1

6.	**Engine installation L242.6000-00.00**
6.1	Exhaust center pin broken away from outer sheet
6.2	Engine driven pump damaged cooling shroud
6.3	Reposition clamp on L/H hose from no. 1 heat exchanger
7.	**Engine systems L242.7000-00.00**
7.1	Fuel leakage – drain-off valve of right wing tip tank
7.2	Shorten hose on drain from electric fuel pump so drain is all down hill
8.	**Cabin equipment L242.8100-00.00**
8.1	Damaged side safety belts L.H. + R.H.
9.	**Board equipment; Cabin ventilation and rating L242.8200-00.00, L242.8300-00.00**
	-OK
10.	**Electrical system L242.8500-00.00**
10.1	Lock wire AMU fuse holder
11.	**Radio Equipment L242.8600-00.00**
	-OK
12.	**Electrical Lighting L242.8900-00.00**
	-OK

Main spar pressure 240 kPa

A	**Failures which must be removed No.:**
	1.1, 3.1, 4.4, 5.1, 6.1, 6.2, 6.3, 7.1, 7.2, 8.1, 10.1
B	**Failures which are recommended to removed No.:**
	2.1, 2.2, 3.2, 4.1, 4.2, 4.3
C	**Failures which hasn't influence to airworthy No.:**
	N/A

The failures have been introduced to Mr. Rick Houle

OCT 10/18

2

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