# 1. Obsah

## 2. Summary:

The aeroplanes UFM are controled along their lateral and vertical axes by an elevator and a rudder. According to their variants the rollings is controled by means of flapperons at UFM-13, or ailerons at UFM-11. Corresponding action elements are controled by a pilot from the cocpit using one of two control sticks of double control system.

We incorporate a system for lift increasing represented by flaps at UFM-11 and flapperons at UFM-13 into the control system. The flaps or flapperons are controled from the cocpit by means of one lever placed between pilots´ seats.

It is necessery to determine forces originate with a pilot, and hinge moments generated by the load of the control surfaces , to be able to carry out the strength analysis of the aktion elements and their mechanisms ( driving parts). According to positions of stops and length ratios the forces acting on individual elements are calculated and the elements checked up.

Different national regulations define different demands on the control system. We suppose to obtain certifications for various countries, and to reach the certifications according to JAR-VLA gradually. This is the reason for such design that mechanical parts, e.g. control system, would not have to be redesignet and exchanged in future. Four basic regulations, according to which the aeroplanes are supposed to be certified, were used for comparsion:

-UL-2 Czech republic
-P-ULL-1 Slovak republic
-Bfu BRD
-JAR-VLA

Provided it was possible, the most strict demand that covered the other regulations was chosen. The final version of the regulation UL-2 has not been finished yet. This is why the highest proposed values were used, including the minimum forces inside the control system that were supposed to be calculated from the 45% - 60% of the force from a pilot .

## 3. Comparison of regulations.

The following are short comments on corresponding paragraphs of individual regulations.

### 3.1 System of elevator control.

#### 3.1.1 UL-2

C.IV.1 The load of the control system.

All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …

In no case the load of any part of the system can be lower than 60% of the force from a pilot.

C.IV.2 The load by the force from a pilot.

Up to the stops the system must be designed to the following forces from a pilot: pull, push

350 N

C.IV.3 Double control system.
Double control system must be designed to incorporate:
a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

### 3.1.2 Bfu

C.IV.1 The load of the control system.
All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …
In no case the load of any part of the system can be lower than 60% of the force from a pilot.

C.IV.2. The load by the force from a pilot
Up to the stops the system must be designed to the following forces from a pilot: pull, push
200 N

C.IV.3. Double control system
Double control system must be designed to incorporate:
a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

### 3.1.3 P-ULL1

395.. The load of the control system
a) … the system is loaded by 125% of the hinge moments of the control surfaces according to the enclosure 1
b) ….the system is loaded by the pull or push on the control stick by the force of 450 N

- the load acts inside of the whole system
- when there is a double control both pilots act at opposit directions

### 3.1.4 JAR-VLA JAR-VLA 395. The load of the control system

a) ….the control system and the hinge structure must be designed to the load corresponding to125 % of the hinge moments of the control surfaces….
3) The load of the system do not have to exceed the maximum forces that is a pilot able to generate. Maximum forces from pilot do not have to exceed the maximum value 74 daN on control sticks…
4) The desing must be done at any case so that the system must comply with hard conditions cosidering breaking, wind gust, taxiing…. This subparagraph can be proved by the design of the system conforming at least to the minimum force of 44,5 daN.

JAR-VLA 399: Double control system

Double control system must be designed to incorporate:
a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

The decisive regulations will be JAR-VLA and the Slovak one for the simultaneous acting of both pilots.

## 3.2 System of rudder control.

### 3.2.1 UL-2

C.IV.1. The load of the control system
All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …
In no case the load of any parts of the system can be lower than 60% of the force from a pilot.

C.IV.2 The load by the force from pilot.
a) Up to the stops the system must be designed to the following forces from a pilot acting on one pedal 600 N
b) …the system must be designed to the load of 600 N on each pedal when simultaneous acting on both pedals

C.IV.3 Double control system
Double control system must be designed to incorporate:
a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

### 3.2.2 Bfu

C.IV.1. The load of the control system
All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …
In no case the load of any parts of the system can be lower than 60% of the force from a pilot.

C.IV.2 The load by the force from pilot.
Up to the stops the system must be designed to the following forces from a pilot acting on one pedal 300 N

C.IV. Double control system
a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

#### 3.2.3 P-ULL1

395.. The load of the control system

c) a) … the system is loaded by 125% of the hinge moments of the control surfaces according to the enclosure 1

b)…. the system is loaded by the force 600 N on a pedal

- the load acts inside of the whole system
- when there is a double control both pilots act at opposit directions

#### 3.2.4 JAR-VLA

JAR-VLA 395.The load of the control system

c) ….the control system and the hinge structure must be designed to the load corresponding to125 % of the hinge moments of action elements….

JAR-VLA 397 The operational control forces

c)… system must be design for load 900 N on each of pedals simultanously

3) The load of the system do not have to exceed the maximum forces that is a pilot able to generate. Maximum forces from pilot do not have to exceed the maximum value 89 daN on pedal…

4) The desig must be done at any case so that the system must comply with hard conditions cosidering breaking, wind gust, taxiing…. This subparagraph can be proved by the design of the system conforming at least to the minimum force of 58 daN.

JAR-VLA 397 The operational control forces

c) … the system must be designet to the load of 900 N on a pedal when simulaneous acting on both pedals

JAR-VLA. 399Double control system

Double control system must be designed to incorporate:

a) simultaneous acting both pilots in the same direction

b) simultaneous acting both pilots in the opposite directions

It calculates with 75% of the force from a pilot.

The decisive regulations will be JAR-VLA and the Slovak one for the simultanous acting on both pedals.

### 3.3 System of ailerons control.

#### 3.3.1 UL-2

C.IV.1. The load of the control system

All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …

In no case the load of any parts of the system can be lower than 60% of the force from a pilot.

C.IV.2. The load by the force from a pilot

Up to the stops the system must be designed to the following forces from a pilot: side force
200 N

C.IV.3. 399 Double control system
Double control system must be designed to incorporate:

a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

### 3.3.2 Bfu

C.IV.1. The load of the control system
All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …
In no case the load of any parts of the system can be lower than 60% of the force from a pilot.

C.IV.2 The load by the force from a pilot
Up to the stops the system must be designed to the following forces from a pilot: side force 150 N

C.IV. Double control system
Double control system must be designed to incorporate:

a) simultaneous acting both pilots in the same direction
b) simultaneous acting both pilots in the opposite directions
It calculates with 75% of the force from a pilot.

### 3.3.3 P-ULL1

395 The load of the control system
c)… the system is loaded by 125% of the hinge moments of the control surfaces according to the enclosure 1
d)….the system is loadetd by the side force of 200 N on the control stick

- the load acts inside of the whole system
- when there is a double control both pilots act at opposit directions

### 3.3.4 JAR-VLA

JAR-VLA 395 The load of the control system.
b) …. the control system and the hinge structure must be designed to the load corresponding to 125 % of the hinge moments of control surfaces….

5) The load of the system do not have to exceed the maximum forces that is a pilot able to generate. Maximum forces from pilot do not have to exceed the maximum value 30 daN on control sticks…
6) The desing must be done at any case so that the system must comply with hard conditions cosidering breaking, wind gust, taxiing…. This subparagraph can be proved by the design of the system conforming at least to the minimum force of 17,8 daN.

JAR-VLA 399 Double control system:

a) simultaneous acting both pilots in the same direction

b) simultaneous acting both pilots in the opposite directions

It calculates with 75% of the force from a pilot.

The decisive regulations will be the Slovak one.

## 3.4 System of flaps control.

As the forces generated by a pilot concernes we consider the system of flaps control as a control element handed by one hand without any pilot-body help.

### 3.4.1 UL-2

C.IV.1The load of the control system.

All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …

In no case the load of any parts of the system can be lower than 60% of the force from a pilot.

C.IV.2. The load by the force from a pilot

Up to the stops the system must be designed to the following forces from a pilot: pull, push

150 N

### 3.4.2 Bfu

C.IV.1 The load of the control system.

All parts between the stop and the control surface of the control system must be designed to the load corresponding at least to 125% of the hinge moment …

In no case the load of any parts of the system can be lower than 60% of the force from a pilot.

C.IV.2 . The load by the force from a pilot

Up to the stops the system must be designed to the following forces from a pilot: pull, push

150 N

### 3.4.3 P-ULL1

395.. The load of the control system

a)… the system is loaded by 125% of the hinge moments of the control surface according to the enclosure 1

b)….the system is loaded by pull or push of 300 N on the control stick

- the load acts inside of the whole system

### 3.4.4 JAR-VLA

JAR-VLA 395 The load of the control system

a)…. the control system and the hinge structure must be designed to the load corresponding to 125 % of the hinge moments of control surface …

JAR-VLA 405 The secondary control system.

The secondary control system must be designet to the following force from a pilot: 350 N

The decisive is the regulation JAR-VLA.

## 4. Selection of loads.

In the follpwing tablet are introduce reviews loads on the control surfacis, critical loads, according those will be design the construction. These are red.

The introduced values are values operational f=1

In addition are in the reviews the values according JAR-22 only for orientation and latter possible modification on the glider.

## Pilot forces load

| | UL-2 | Bfu | P-ULL1 | JAR-22 | JAR-VLA | |
|---|---|---|---|---|---|---|
| | Load the control surface | | | | | remark |
| | [N] | [N] | [N] | | [N] | [] |
| elevator | 350 | 200 | 450 | 350 | 445 | P-ULL1 |
| rudder | 600<br>600 | 300<br>- | 600<br>- | 900<br>1000 | 580<br>900 | P-ULL1<br>JAR-22 simult. acts on both pedals |
| ailerons | 150 | 150 | 200 | 200 | 178 | P-ULL1 |
| flaps | 150 | 150 | 300 | 350 | 350 | JAR-VLA |

## Hinge moments on the control surfacis

| | Hinge moment max. | Typ |
|---|---|---|
| | [Nmm] | [] |
| **elevator** | 38000 | UFM-11,13 |
| **rudder** | 23866 | UFM-11,13 |
| **ailerons** | 10068 | UFM-11 |
| **flapperon +** | 49140 | UFM-13 |
| **flapperon -** | -28624 | UFM-13 |
| **flaps+** | 31900 | UFM-11 |
| **plaps-** | -7975 | UFM-11 |

The source for hinge moments are the reports „Load of UFM-13, UFM 11“ and „Load of flaps and ailerons“