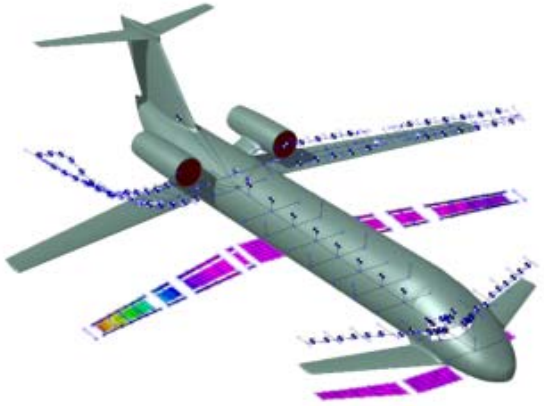
Sizing manoeuvres in GUESS

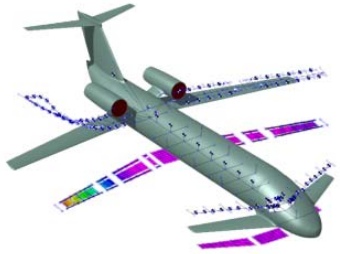


July 2018

NeoCASS 2.2.809
NeoRESP 1.0.104

Sizing Condition List

- MANOEUVRING BALANCED CONDITIONS
- HIGH LIFT DEVICES
- HORIZONTAL TAIL SURFACES
- YAW MANOEUVRE CONDITIONS
- ROLLING CONDITIONS
- GUST CONDITIONS
- TAIL DOWN LANDING
- ENGINE OUT CONDITIONS

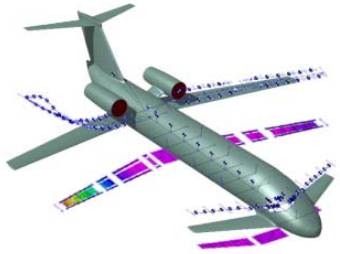


MANOEUVRING BALANCED CONDITIONS

CS 25.331 b / CS 23.333

"Manoeuvring balanced conditions. Assuming the aeroplane to be in equilibrium with zero pitching acceleration, the manoeuvring conditions A through I on the manoeuvring envelope in CS 25.333 (b) must be investigated."

"Compliance with the strength requirements of this subpart must be shown at any combination of airspeed and load factor on and within the boundaries of a flight envelope (similar to the one in sub-paragraph (d)) that represents the envelope of the flight loading conditions specified by the manoeuvring and gust criteria of sub-paragraphs (b) and (c) respectively."



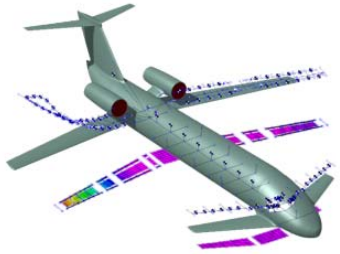
Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	SIDES	0,0	ROLL	0,0
	PITCH	p	YAW	0,0	URDD2	0,0	THRUST	0,0
	URDD4	0,0	URDD5	0,0	URDD6	0,0	CLIMB	0,0
	BANK	0,0	HEAD	0,0	URDD3	Zacc		

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

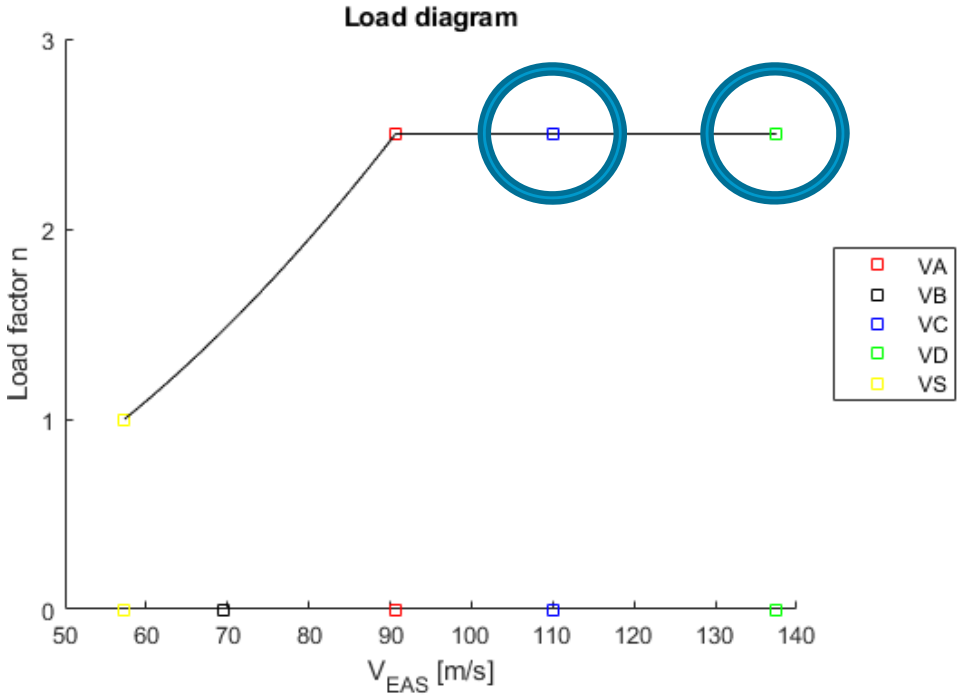
$$Zacc = Max\ load\ factor\ *\ 9{,}81\ \mathrm{m}/s^2$$

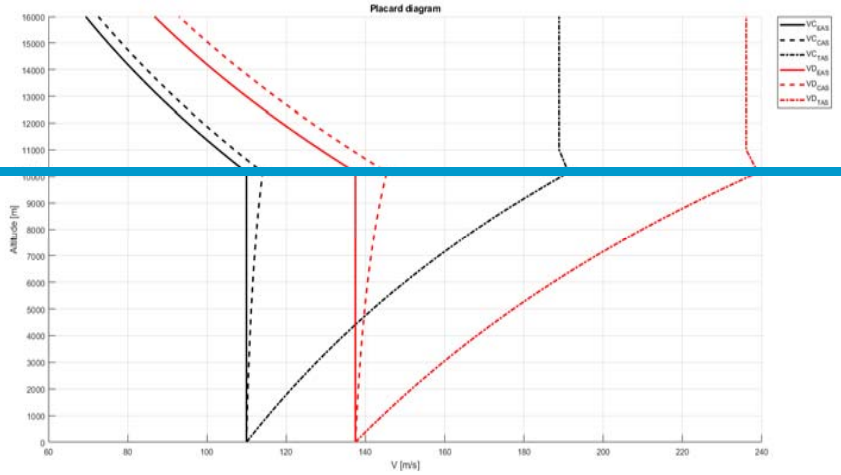
$$p = \frac{9{,}81(Nmax - 1)\ c_{ref}}{2{v_{ref}}^2}$$



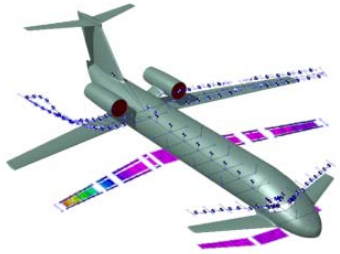
4 loading conditions

Mach number	Altitude
MD	0 m
MD	HD
MC	0 m
MC	HC





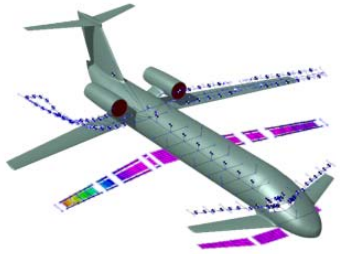
HC ~ HD



HIGH LIFT DEVICES

CS 25.345 / CS 23.345

"(a) If flaps or similar high lift devices are to be used for take-off, approach or landing, the aeroplane, with the flaps fully extended at VF, is assumed to be subjected to symmetrical manoeuvres and gusts within the range determined by
(1) Manoeuvring to a positive limit load factor of 2·0; and
(2) Positive and negative gusts of 7.62 m/sec (25 ft/sec) EAS acting normal to the flight path in level flight."



Nastran like TRIM card (1)

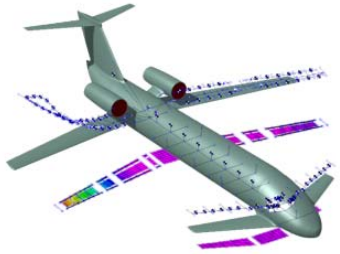
TRIM	Ntrim	1	Mach	Altitude	SIDES	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	URDD2	0,0	THRUST	0,0
	URDD4	0,0	URDD5	0,0	URDD6	0,0	CLIMB	0,0
	BANK	0,0	HEAD	0,0	URDD3	Zacc	FLAP	Landing deflection

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: no other deflections imposed) .

$$\text{Zacc} = 2 * 9{,}81\ \text{m/s}^2$$

Altitude = 0 m

Mach corresponding to VF



Nastran like TRIM card (2)

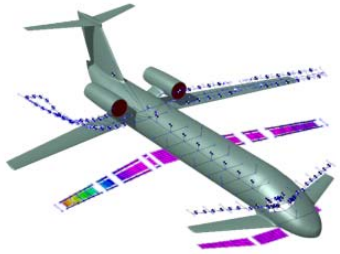
TRIM	Ntrim	1	Mach	Altitude	SIDES	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	URDD2	0,0	THRUST	0,0
	URDD4	0,0	URDD5	0,0	URDD6	0,0	CLIMB	0,0
	BANK	0,0	HEAD	0,0	URDD3	Zacc	VGUST	7,62
	FLAP	Landing deflection						

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: no other deflections imposed) .

$$\text{Zacc} = 2 * 9{,}81\ \text{m/s}^2$$

$$\text{Altitude} = 0\ \text{m}$$

Mach corresponding to VF



HORIZONTAL TAIL SURFACES

CS 25

CS 25 requires horizontal tail surfaces conditions to be taken into account with dynamic analyses (CS 25.331 (c)). CS 23 simplified formulations are used for CS 25, too.

CS 23.423

"(b) A sudden aft movement of the pitching control at speeds above VA, followed by a forward movement of the pitching control resulting in the following combinations of normal and angular acceleration:

Nose-up pitching:

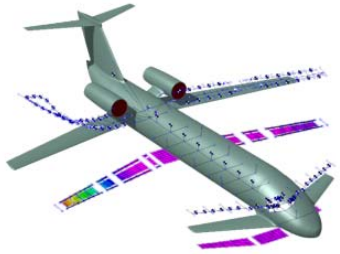
Angular: + 39 V nm (nm 1.5)

Normal: 1g

Nose-down pitching:

Angular: − 39 V nm (nm 1.5)

Normal: Nmax"

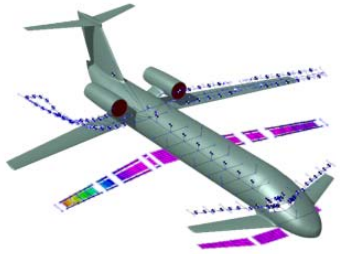


Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	SIDES	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	URDD2	0,0	THRUST	0,0
	URDD4	0,0	BANK	0,0	URDD6	0,0	CLIMB	0,0
	HEAD	0,0	URDD3	Zacc	URDD5	Pacc		

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

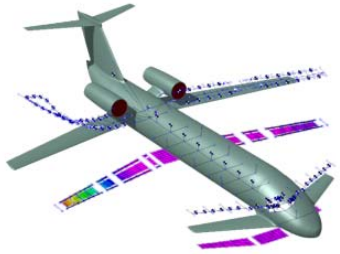
Altitude = 0 m



6 loading conditions

Speed	Normal acceleration	Angular acceleration
VA	9,81	+Pacc
VA	9,81*Nmax	-Pacc
VC	9,81	+Pacc
VC	9,81*Nmax	-Pacc
VD	9,81	+Pacc
VD	9,81*Nmax	-Pacc

$$\text{Pacc} = \frac{39}{\text{V}}\text{Nmax}(\text{Nmax} - 1{,}5)$$

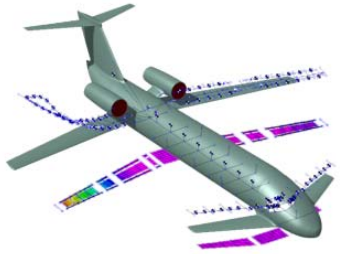


YAW MANOEUVRE CONDITIONS

CS 25.351/CS 23.351

"The aeroplane must be designed for loads resulting from the yaw manoeuvre conditions specified in sub-paragraphs (a) through (d) of this paragraph at speeds from VMC to VD. Unbalanced aerodynamic moments about the centre of gravity must be reacted in a rational or conservative manner considering the aeroplane inertia forces. In computing the tail loads the yawing velocity may be assumed to be zero. "

"The aeroplane must be designed for yawing loads on the vertical surfaces resulting from the loads specified in CS 23.441 to 23.445. "

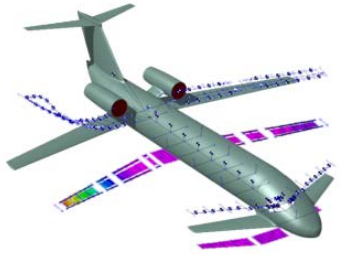


YAW MANOEUVRE CONDITIONS

CS 25.351 (a)/CS 23.441(a)(1)

"With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the cockpit rudder control is suddenly displaced to achieve the resulting rudder deflection, as limited by: (1) the control system or control surface stops; or (2) a limit pilot force of 1335 N (300 lbf) from VMC to VA and 890 N (200 lbf) from VC/MC to VD/MD, with a linear variation between VA and VC/MC. "

"With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the rudder control is suddenly displaced to the maximum deflection, as limited by the control stops or by limit pilot forces."

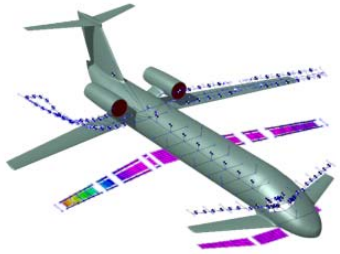


Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	HEAD	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	SIDES	0,0	THRUST	0,0
	BANK	0,0	CLIMB	0,0	URDD5	0,0	URDD3	Zacc
	RUDDER	Max Def						

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

Altitude = 0 m

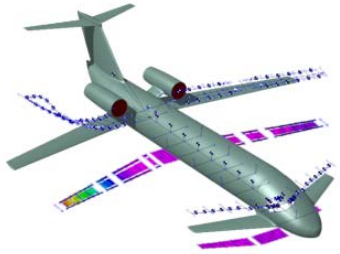


YAW MANOEUVRE CONDITIONS

CS 25.351 (b)/CS 23.441(a)(2)

"With the cockpit rudder control deflected so as always to maintain the maximum rudder deflection available within the limitations specified in sub-paragraph (a) of this paragraph, it is assumed that the aeroplane yaws to the overswing sideslip angle. "

"With the rudder deflected as specified in sub-paragraph (1), it is assumed that the aeroplane yaws to the overswing sideslip angle. In lieu of a rational analysis, an overswing angle equal to 1·5 times the static sideslip angle of sub-paragraph (3) may be assumed. "



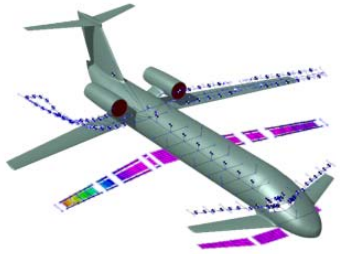
Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	HEAD	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	SIDES	Beta	THRUST	0,0
	BANK	0,0	CLIMB	0,0	URDD5	0,0	URDD3	Zacc
	RUDDER	Max Def						

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

Altitude = 0 m

Beta = 1,5 *15°

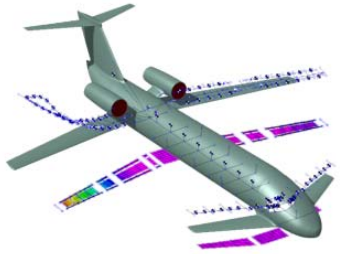


YAW MANOEUVRE CONDITIONS

CS 25.351 (d)/CS 23.441(a)(3)

“With the aeroplane yawed to the static equilibrium sideslip angle of sub-paragraph (c) of this paragraph, it is assumed that the cockpit rudder control is suddenly returned to neutral. ”

“A yaw angle of 15° with the rudder control maintained in the neutral position (except as limited by pilot strength). ”



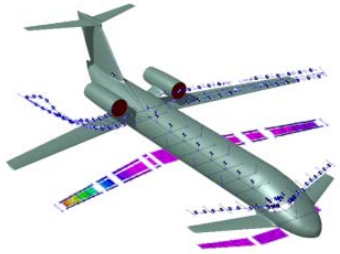
Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	HEAD	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	SIDES	Beta	THRUST	0,0
	BANK	0,0	CLIMB	0,0	URDD5	0,0	URDD3	Zacc
	RUDDER	0,0						

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

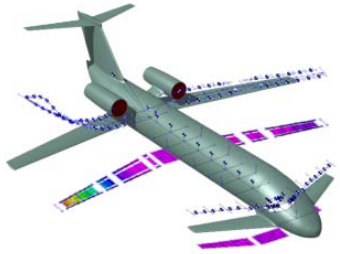
Altitude = 0 m

Beta = 15°



12 loading conditions

Regulation	Sides	Rudder	Speed
(a)	0°	+ Max def	VA
(a)	0°	- Max def	VA
(a)	0°	+ Max def	VS
(a)	0°	- Max def	VS
(b)	1,5*15°	+ Max def	VA
(b)	-1,5*15°	- Max def	VA
(b)	1,5*15°	+ Max def	VS
(b)	-1,5*15°	- Max def	VS
(d)	15°	0°	VA
(d)	-15°	0°	VA
(d)	15°	0°	VS
(d)	-15°	0°	VS

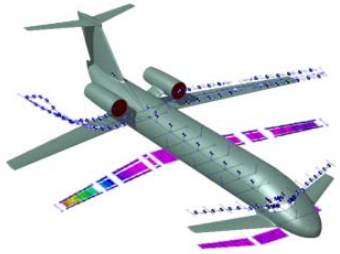


ROLLING CONDITIONS

CS 25.349/CS 23.349

“For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the manoeuvre. (2) At VA, a sudden deflection of the aileron to the stop is assumed. ”

“Sudden maximum displacement of the aileron control at VA. Suitable allowance may be made for control system deflections. ”



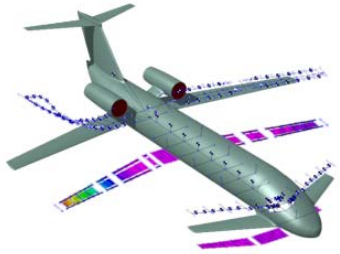
Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	HEAD	0,0	ROLL	0,0
	PITCH	p	YAW	0,0	SIDES	0,0	THRUST	0,0
	BANK	0,0	CLIMB	0,0	URDD5	0,0	URDD3	Zacc
	AILERON	Max def						

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

Altitude = 0 m

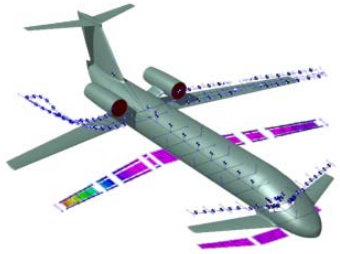
$$p = \frac{9{,}81(Nmax - 1)\, c_{ref}}{2{v_{ref}}^2}$$



4 loading conditions

Speed	Aileron	Load Factor
VA	+ Max def	1
VA	- Max def	2/3 Nmax
VA	+ Max def	1
VA	- Max def	2/3 Nmax

Zacc = Load Factor * 9,81 m/s^2



GUST CONDITIONS

CS 25

CS 25 requires gust conditions to be taken into account with dynamic analyses (CS 25.341). CS 23 simplified formulations are used for CS 25, too.

CS 23.333(c)

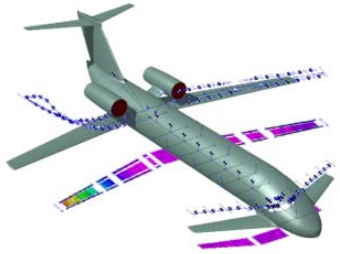
(c) In the absence of a more rational analysis the gust load factors must be computed as follows:

$$n = 1 \pm \frac{kg\,\rho o\,Ude\,Va}{2(W/S)}$$

where –

$kg = \frac{0.88\mu g}{5.3 + \mu g}$ = gust alleviation factor;

$\mu g = \frac{2(W/S)}{\rho \bar{C} ag}$ = aeroplane mass ratio;

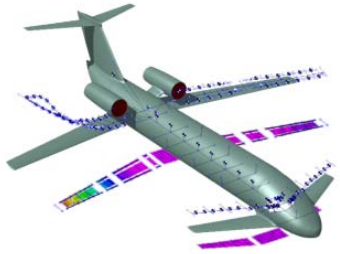


Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	SIDES	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	URDD2	0,0	THRUST	0,0
	URDD4	0,0	URDD5	0,0	URDD6	0,0	CLIMB	0,0
	BANK	0,0	HEAD	0,0	URDD3	Zacc	VGUST	gust

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: Flap deflection = 0°) .

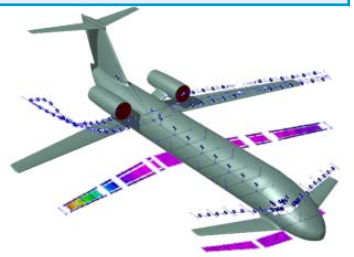
$$Zacc = 9{,}81\ m/s^2$$



6/9 loading conditions

CS 25		
Speed	Gust	Altitude
VC	17,08 m/s	0 m
VC	13,42 m/s	4575 m
VC	7,93 m/s	15250 m
VD	8,54 m/s	0 m
VD	6,71 m/s	4575 m
VD	3,97 m/s	15250 m

CS 23		
Speed	Gust	Altitude
VB	20,13 m/s	0 m
VB	20,13 m/s	4575 m
VB	11,59 m/s	15250 m
VC	17,08 m/s	0 m
VC	17,08 m/s	4575 m
VC	7,93 m/s	15250 m
VD	8,54 m/s	0 m
VD	8,54 m/s	4575 m
VD	3,97 m/s	15250 m

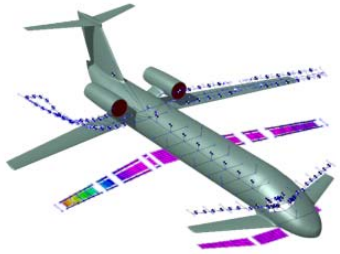


TAIL DOWN LANDING

CS 25.481/ CS 23.481

"In the tail-down attitude, the aeroplane is assumed to contact the ground at forward velocity components, ranging from VL1 to VL2 , parallel to the ground under the conditions prescribed in CS 25.473"

"For a tail down landing, the aeroplane is assumed to be in the following attitudes: (1) For aeroplanes with tail wheels, an attitude in which the main and tail wheels contact the ground simultaneously. (2) For aeroplanes with nose wheels, a stalling attitude, or the maximum angle allowing ground clearance by each part of the aeroplane, whichever is less. "



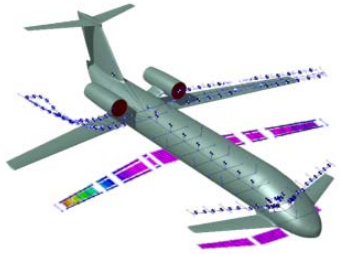
Nastran like TRIM card

TRIM	Ntrim	1	Mach	Altitude	SIDES	0,0	ROLL	0,0
	PITCH	0,0	YAW	0,0	URDD2	0,0	THRUST	0,0
	URDD4	0,0	URDD5	0,0	URDD6	0,0	CLIMB	0,0
	BANK	0,0	HEAD	0,0	URDD3	Zacc	VSINK	Vsink
	STROKE	Stroke	LNDGEFF	Eff				

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: no other deflections imposed) .

$$Zacc = 9{,}81\cos\left(\frac{Vsink}{Vland}\right) m/s^2$$

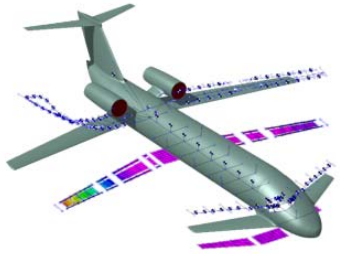
Altitude = 0 m



2/1 loading condition(s)

CS 25	
Speed	Vsink
Vland	3,05 m/s
Vland	1,83 m/s

CS 23	
Speed	Vsink
Vland	0,92 m/s

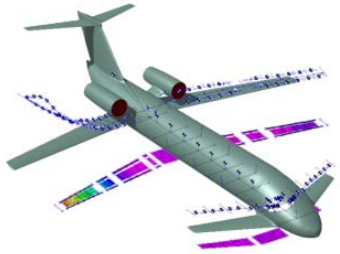


ENGINE OUT CONDITIONS

CS 25.121/CS 23.67

"The aeroplane must be designed for the unsymmetrical loads resulting from the failure of the critical engine. "

"Turbopropeller aeroplanes must be designed for the unsymmetrical loads resulting from the failure of the critical engine including the following conditions in combination with a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls. "



Nastran like TRIM card

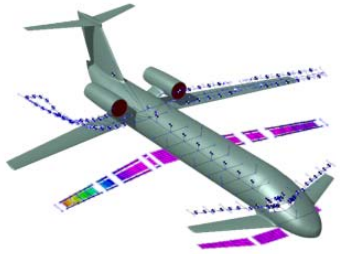
TRIM	Ntrim	1	Mach	Altitude	ROLL	0,0	THRUST	0,0
	PITCH	0,0	YAW	0,0	URDD2	0,0	CLIMB	0,0
	URDD4	0,0	URDD5	0,0	URDD6	0,0	BANK	0,0
	HEAD	0,0	URDD3	0,0	FLAP	Takeoff		

+ control surfaces deflections imposed by the user, depending on aircraft configuration (Default: no other deflections imposed) .

+ MOMENT coming from max critical engine power not balanced by the other one (failure condition).

$$Zacc = 9{,}81\cos(\mathrm{atan}(ClimbGrad))\, m/s^2$$

Altitude = 0 m



0/1/2 loading condition(s)

	2 engines	3 engines	4 engines
CS 23	1 engine failure	-	-
CS 25	1 engine failure	1 engine failure	2 engines failure