

Offshore 508 Guidelines

2011-04-18

This Guideline is created by CominOff and CominSafe and developed to make it easier for builders, teams, measurers and scrutineers to understand the present rules, to guide builders and to make racing safer. The Guidelines are here inserted in the Offshore 508 and 730.2 rules. The rules are printed in black, the Guidelines are printed in italic and blue. The Guideline is a compilation of inspection requirements and includes design examples for cockpit registration. It is an update of the 2010 draft and includes information gained from the 2010 racing season.

The Guideline will be updated on an ongoing basis as new information becomes available. Presently, there is on-going analysis and discussion regarding two items, window minimum thickness and the flange dimension. When this analysis is completed the information will be added to the guidelines.

Information for Offshore 3 cockpit boats for season 2011

508 - CREW SAFETY

All other 508 Rules apply to all categories of boats.

All Class 1 mono/multi and Class 3 / 6 litre mono/multi only must be equipped with a Reinforced Cockpit(s) with Canopies for all riding crew members and buoyancy to ensure the boat floats. The crew, who must be seated, must have a restraint system comprising of and conforming with the following rules:

A Reinforced Cockpit with Canopies is defined as a containment area for crew and can be constructed as an integral part of the boat. This Reinforced Cockpit Area must be designed and constructed to a specification capable of withstanding the forces of a water impact when running at the highest design speed of the boat, and therefore protecting all members of the crew in the event of an accident. The various components that constitute the Reinforced Cockpit shall be properly maintained to ensure reliable operation of all components, with emphasis being placed on the canopy release mechanism, emergency air supply and restraint systems.

In any Class 1 multihull boat, Cockpits will not be allowed in the sponsons. It is recommended that Sponson Cockpits not be used in any other classes.

These rules also apply to any boat in any class using Reinforced Cockpits with Canopies.

508.01 - COCKPIT EVACUATION / IMMERSION TESTING

Before racing in a craft with restraint systems, all crews must have passed in the last fourteen months, an immersion test in a restraint system to ensure that they can exit a reinforced cockpit crew compartment successfully.

Prior to taking the immersion test, all crews must have a valid scuba certificate or have received suitable training. This alternative training should be approved by the National Authority.

An Immersion Certificate to certify the passed test, showing the expiry date, must be delivered by Experts recognised by a National Authority.

All riding crew members using restraints must sign the National indemnity form prior to competing in any race or practice.

508.02 - DRAWINGS AND MEASUREMENT

Three view drawings (plan, side and elevation) of the design of the Reinforced Crew Cockpits(s), the Bulkheads, the type of Canopy, the Buoyancy System and the Restraint System anchorage Points must be lodged with the National Authority of the measurer and verified at the time of craft measurement. Drawings shall be provided showing canopy aperture dimensions for full or partial canopies, single or tandem arrangements. Arrangements shall describe whether fore and aft, or side by side seating is fitted.

Drawings shall show the method and construction of release devices. Drawings should show the material specification of the transparent areas.

Prior to Boat Measurement the drawing and material specifications shall be sent to the Measurer requested to measure the boat. On completion of measurement, the drawings and material specifications called for by the designer shall be lodged with the measurers National Authority before they issue a certificate of compliance and measurement.

Cominoff

*ALL Offshore 3C canopied boats have to be measured or re-measured after January 2010
There shall be two measurers working together, and they shall use the Offshore
Measurement certificate & Logbook and the latest version of the Offshore 3 cockpit checklist:*

*Collect all earlier history information of the canopy and the boat.
Take photographs of the canopy outside and inside – with boats ID on the photos.*

Log book information to be filled in as shown in the logbook, the registration number of the cockpit shall also be included in the logbook. Log book to be kept with the boat and be presented to the scrutineer at a race

*Photos and information of any damage and repair are to be included.
At a race, check to be sure that the cockpit is on the registered list.*

The cockpit registration is obtained by the designer submitting the information regarding the design and analysis for the cockpit, together with the registration form, showing that the cockpit complies with the guidelines and the rules and the registration accomplished by a Cominoff designated person (scrutineer, engineer), The drawings of the cockpit design and lay-up are filed at the NA. Upon a satisfactory review of the documentation, that will be the UIM Offshore 3 cockpit registration will then be listed on the UIM cockpit registration list.

For cockpits built before January 2010, the cockpit drawings and lay-up filed at NA will be sufficient for registration. For existing boats where the cockpit drawings are not on file nor have not been submitted and reviewed, review and registration of the cockpit must take place prior to participating in an international race. For example, suppose that the builder has not submitted drawings or analysis, or may not be in business currently, not able to submit the required information. In this case, it will be necessary for the owner to secure the services of a builder or scrutineer for the purpose of examining the boat against the Guidelines and appendices and determining that the strength and security described in the Guidelines is satisfied. They must then fill in the registration form and send that to the N.A. Specific questions may be directed to CominOff or CominSafe.

Scrutineering

*Check the requested drawings of the cockpit design and lay-up and make sure that the drawings are filed at the NA, and that the registration has been listed on the UIM cockpit registration list.
At a race, check to be sure that the cockpit is on the registered list.*

508.03 - REINFORCED COCKPIT AREA AND CANOPY

All boats with restraints must have a Reinforced Cockpit Area with Canopy, which should be constructed entirely of materials equal to the strength of the running surface of the boat, or stronger. This area must be the sides, floor, decking and bulkheads fore and aft.

It is mandatory to close the canopy with a hatch, and the hatch to remain closed during all racing and practice.

It is strongly recommended that a "Floor Escape Hatch" is the secondary means of escape.

Offshore 3 except 3S (§730.2)

The reinforced cockpit(s) shall be of a closed type design with a minimum of one opening hatch and constructed to a similar strength as the running surface of the boat.

Guideline

In an emergency situation it is of utmost importance that the crew can easily escape.

Water deflectors

- *Water deflectors should be on the deck and under the deck forward and aft of the canopy.*
- *If the boat does a air-roll lands at full speed and lands upside down the hatch will take a massive load. This load can be spread out a bit by having water deflectors in front of the openings, in all directions.*
- *If the boat stuffs at full speed the solid water on deck will have a massive impact on the lower fastening of the window. A water deflector will aerate the solid water and spread loads.*
- *If the boat stuffs at full speed the forward part of the boat may be damaged and water will rush inside the boat against the canopy inside wall. This can also happen with a cat when flipping backwards and then stuff backwards. (See bulkhead notes above) A V-shaped water deflector can spread the loads before it hits the canopy walls.*

Scrutineering

- *Can the crew open the escape hatch when strapped in and air in the mouth?*
- *Do we have anything that the life vest or other cloth parts can be trapped in?*
- *Do we have anything that feet could be trapped in?*
- *Any hard spots that can be dangerous?*
- *All equipment well strapped in, no loose stuff.*

508.04

Canopies must be a composite structure with the following features. (§508.05- 26)

508.05 Windows

Polycarbonate areas are strongly recommended to be as small as possible while still maintaining that the driver and co-driver have clear, safe and undisturbed visibility ahead at sea level whilst racing. For Class 1 it is strongly recommended that these polycarbonate areas are built using 12 mm thickness, or more.

The combined visibility of driver and co-driver must be through a horizontal arc of 225 degrees (112.5 degrees either side of the centre line of the boat).

These polycarbonate panels are to be recessed into the composite structure and may be bonded using a suitable bonding agent, and/or "bobbins".

It is highly recommended that there is also a through bolted outer flange for the fitting of the polycarbonate panels.

Offshore 3 except 3S (§730.2)

- *The outer edges of the canopy surrounding the hatch, must be fitted with a water deflector, (height 10 mm min) to prevent water forcing open the hatch in the event of a capsize.*
- *Hatches must have a slot for pry bar use in emergency/rescue.*
- *Controlling crew must have clear visibility ahead with adequate panoramic view.*

Window areas:

- *Material: Polycarbonate or similar.*
- *Glass (in any form) is specifically prohibited.*
- *Min thickness of window :*
- *Side by side cockpits min 9.5 mm.*
- *Screens with curvature and/or tandem cockpit min 7.9 mm*

CominOff

- *Strength analysis supplied with cockpit registration information. Canopy thickness, 7,9 mm or greater, recommend 9,5 mm if optical clarity can be maintained and mandatory for side by side cockpits.*
- *Properly fixed. The recommended manner of fixing the polycarbonate to the frame is with bonding. For bolting, a washer is recommended, min 15 mm diameter for each bolt. It is recommended that a “sleeve” or “barrel” around the bolt is used as it passes through the poly.*

Scrutineering

- *Polycarbonate windows will age when exposed to the sun and acids without visible notice. Are they up to date and strong enough?*
- *Check window age and for any previous impacts*
- *Check for cracks.*
- *Check for visibility.*
- *Are they strong enough? (refer to measurement certificate/cockpit registration data)*
- *Are they well fastened to the canopy?*
- *Washer is necessary. Recommend min 15 mm diameter. Recommend use of a “sleeve” or “barrel” around the bolt as it passes through the poly.*

508.06

Screen flanges should be a minimum of 50 mm and should be fastened every 100 mm if using “bobbins”; it is recommended to use metal “bobbins” with heads, as opposed to the recessed plastic type.

The outer polycarbonate area of the flange fitting must not be painted, so that the measurer/ scrutineer may monitor any discrepancies.

Offshore 3 except 3S (§730.2)

- *Window to flanges joints must be glued and/or use bobbins of nylon or aluminium.*
- *Bolts: min 6 mm stainless steel, nylock nuts, washers.*
- *Bolt spacing: max. 10 cm if not glued*
- *The outer edges of the canopy surrounding the hatch, must be fitted with a water deflector, (height 10 mm min) to prevent water forcing open the hatch in the event of a capsize.*

Suggestion to GA 2011

Window flanges should be a minimum of 50 mm at forward direction and 35 mm towards sides.

508.07 Roll bar

These Restraint Cockpits must be fitted with an internal roll bar, two in a tandem cockpit as a minimum. There must also be, between the two single cockpits, an anti-compression strut or structure of similar strength to the roll bar.

Interpretation

- *Roll bar in front of/around each crew member*
- *Roll bar strong enough and well secured to the bottom stringers.*
- *Central compression strut to hold roll bar, for side by side cockpits. Side compression struts may also be necessary for side by side cockpits.*
- *Alternatively, instead of a compression strut, the design of the cockpit primary structure will consist of a center roof rib connected to the roll bar and the aft bulkhead with sufficient strength to satisfactorily react the design impact loads.*
- *Canopy can collapse if the roll bars are not strong enough. The roll bar(s) should also protect the aft crew member.*
- *In a tandem canopy, there needs to be roll bar structure ahead and behind of the driver, and behind the rider, essentially three roll bar structures. For designers/builders that want to use the rear bulkhead as the rear roll bar, the structural loads analysis submitted with the cockpit shall show that the bulkhead is of sufficient strength to act as a roll bar. The aft bulkhead is also required to sustain water impact loads from either fore or aft directions while also sustaining compression loads from impact.*

Guidelines

- *Consider that the aft bulkhead should be curved convex to the rear of the boat to better deflect water impact loads.*
- *The roll bar(s) needs to be strong enough (see measurement certificate criteria/registration) and well secured to the stringers and the bottom of the boat.*
- *Is the roll bar of the same material? The stiffest path will transfer the load to the hull structure. Most important with the dissimilar stiffness is the idea of the load path and whether it is efficient. So, this generally leads to an overall strengthening of the canopy structure, thicker windows, better attachments of the windows, etc..*

508.08

Hatch openings shall have a minimum of 25 mm flange.

Offshore 3 except 3S (§730.2)

Hatches must have a slot for pry bar use in emergency/rescue.

Guideline

The flanges on the roof and hatch are to be of comparable strength and be able to support the hatch

508.09 Hatches

Hatches should be recessed on the front and sides.

Offshore 3 except 3S (§730.2)

The outer edges of the canopy surrounding the hatch, must be fitted with a water deflector, (height 10 mm min) to prevent water forcing open the hatch in the event of a capsize.

Interpretation

Water deflector to be fitted only on front and sides of hatch, not behind of hatch. (A water deflector on back of hatch might force water into cockpit area.)

508.10

It is recommended the hatches are constructed to the same specification as the main Restraint Area. The hatches shall be fitted with a catch which has a positive open and positive close mechanism and should hold the hatch against lateral forces. These hatches shall be able to be opened from both inside and outside the cockpit and must have a second emergency mechanism to allow the rescue team to easily remove the hatch from outside if necessary. These hatches should be fitted with hinges with short release pins. This is important because long pins invariably bind the hinge.

Guideline

The hatch has to be at least as strong as the bottom of the boat and the analysis included in the cockpit registration submittal.

508.11

There should be one or more divers grab handles fitted to the outside of each hatch.

508.12

Canopy hatch release handles, which must be provided both inside and out, must be painted fluorescent orange or have a fluorescent orange background panel to identify them and directional arrows to indicate the method of opening.

Guideline

The hatch opening mechanism shall be of sufficient strength to react the loads and and be easy to open

508.13

The canopy lid hinges and the canopy hatch covers release mechanism must not encroach within the canopy aperture area, and these hinges and release mechanisms must not in any way hinder the exiting of crew members when fully race fitted.

Guideline

The hatch has to be at least as strong as the bottom of the boat and the analysis included in the cockpit registration submittal.

The flanges on the roof and hatch are to be of comparable strength and be able to react the hatch loading.

The hinges shall be bolted with proper backing plates etc.

The safety pins shall be easy to remove.

The hatch opening mechanism shall be of sufficient strength to react the loads and be easy to open.

The intent is to have a hatch that is strong enough to react crash loads due to its material

508.14 Canopy openings

Canopy openings should have the entry/exit apertures located directly above the crews' heads.

The canopy aperture openings should be at least 0.55m in length and 0.55m in width. If the crew is seated side by side, then the opening should be at least 0.55m x 0.825m wide. In tandem configuration, the opening(s) should be 0.55m x 0.55m per crew member. The canopy apertures should be cut with all corners having a radius of 0.025m minimum or 0.25m maximum. The radius should be constant and have a smooth finish to relieve stress.

Offshore 3 except 3S (\$730.2)

Hatch opening per person: 55 x 50 cm min.

508.15

The canopy aperture must have a 20 mm wide (minimum) fluorescent orange band around the opening.

Interpretation

Both inside and outside of the opening

508.16 Air supply

It is mandatory that one single air supply (not oxygen) and a bottle will be provided for each riding crew member. The air supply must be securely fixed adjacent to, or on each one of them. It is recommended that sufficient air be provided in each individual bottle for ten minutes. Air bottles must have a pressure gauge fitted for visual checking at pre-race scrutineering. This gauge should be filled with liquid and be at least 5 cm in diameter for easy reading.

Air supply bottles shall be "Turned On" before starting a race or taking part in practice and/or testing.

Guidelines

- *Air hoses must be long enough to allow crew to stand up in seat*
- *Extra air bottle to help other racers.*

508.17

Reinforced Cockpits must have flood tubes or other means of flooding the cockpit to equalise the pressure quickly in an accident. The floor of the cockpit should be as air tight as possible to help the cockpit pressure equalise far more quickly when in an upturned position.

508.18

Boats with restraints must have stop buttons/switches located in the cockpit area, immediately accessible to driver, co-driver and rescue officers. The stop buttons/switches must be identified by a fluorescent colour.

These switches must shut off all fuel pumps as well as the ignition circuit.

In the case of diesel boats, the stop control cable for the fuel injection pump shall be a non-sleeved cable, so as to eliminate the cable being able to bond in a fire.

508.19 Strobe light

All boats shall have a White High Intensity Strobe Light fitted to indicate "coming off the plane" but not needing assistance. The strobe light must be able to be operated by the throttle man, and should be operated by the throttle man if a problem occurs, to enable any following race boats to take avoiding action. The strobe light shall be mounted on the top rear of the canopy. When duel canopies are used, the light may be on or behind either one.

Suggestion to GA 2011

Strobe light shall be orange

508.20 Head protection

Cockpits with Restraints must be fitted with rear of head protection for each crew member. This must be an integral part of the seat, which must be attached directly to the structure of the Restraint Compartment. The head protection must be a minimum of 0.2m wide and extend at least 75% of the height of the safety helmet as worn by the crew whilst in the normal seating position. There must be a minimum of 0.12m vertical and lateral clearance between the canopy and each of the crewmembers when in the normal seating position.

Offshore 3 except 3S (§730.2)

Clearance: helmet to hatch 10 cm min.

Scrutineering

In an accident the harness will stretch a lot in length and a clearance of 100 mm to the hatch is important to have. Clearance and/or support to the sides of the helmet are also important.

- *Do we have a clearance of at least 100 mm from the helmet to the roof inside for the specific crew member?*
- *The ideal is the helmet has a cushioned side support that can limit extreme motions. If not, are there any hard spots around the helmet that can be reached by then helmet and need to be padded or removed?*

508.21 Harness

- The Restraint System must consist of a 5 or 6 strap harness and should utilise a 75 mm lap belt, a 50 mm strap over the shoulder harness rated at 4,100kg (9,000 lb.) and grommited to prevent chafing or cutting of the belt. Harness straps must be attached directly to the cockpit structure. Those straps close behind the driver's head and neck must be 100 mm to 150 mm apart at point of attachment. The shoulder harness should be installed at 90 degrees to the spine at shoulder line to minimise compression injuries under high "G" loading. All straps must be free to run through intermediate loops or clamps/buckles. All anchor point bolts must be fitted with backing plates of 10cm minimum width.
- The driver harness attachment bolts in reinforced cockpits must consist of minimum grade EN8 bolts, with an 8 x 1.25 mm thread and locked nuts. There must be a spacer and plain washers on each bolt. The spacers must be glued to the cockpit structure. Intention of these spacers is to prevent buckling of surface material near bolts. This always leads to local delamination which easily spreads out over cockpit structure, when it is under stress.
- On the sides of the structure, which has to take up the force on the attachment bolts, there must be a stainless steel plate (washer of minimum 3 mm thickness and 100 cm² area).
- When using seats with suspension, and therefore not using a bulkhead restraint anchorage, drawings must be lodged with the National Authority of the measurer and approved prior to boat measurement.
- All restraint systems must have a common method of release. The single lever method (sometimes called the NASCAR type) or rotary type, are both acceptable restraint release systems.
- Both types of restraint release must be examined for satisfactory operation by the scrutineer before every race.
- The harness system must comply with Drawing 2.
- The shoulder harness should be installed 90 degrees to the spine at shoulder line to minimise compression injuries and the high "G" loading.

- 75 mm minimum/maximum to Centre line of Lap Belt at Seat Back, Seat Bottom junction. Lap Belt should continue in straight line to anchorage.

Guidelines

Belts

- *50mm lap belt, 6 or 7 point restraint strongly recommended Note: It has been learned from the car racing side that the harness fixing points geometry are crucial for taking the loads of the human body. Remember that an impact can apply substantial loads to the body at even low velocities. The second point is that from numerous laboratory tests and now two seasons running with these belts in competition that the 6-7 point belt provides better limiting of the hip movement, which helps limit the torso movement, which limits the overall head and neck movement.*
- *Placed in proper position for the specific crew. Belt attaching angles as shown by the belt manufacturer. (Information shown on web sites)*
- *Lever latch strongly recommended, Locking device maintenance is **important**.*
- *Well fixed, reinforced bar, strong big backing plates*
- *Belts shall be replaced after any accident*

Seats

- *Seat with lumbar support, solidly mounted, restraint belts do not press on the seat, angles of belts proper for the driver.*

508.22 Steering wheel

A quick release steering wheel may be fitted on a boat with personal restraints, but all drivers must be able to exit the cockpit without removing the steering wheel.

508.23

Rear view mirrors are mandatory, as well as a method of cleaning the canopy whilst under way.

508.24

For Class 3C, one extinguisher is sufficient.

Two fire extinguishers, each a minimum of 2kg, or of equivalent capacity, must be carried and be readily accessible to the crew.

The flares described in U.I.M. Offshore Rule 715.10 may be placed in a shallow locker adjacent to the deck race number.

Should a life raft be carried, it may be placed in the same locker.

All crew containment areas of inboard engine 508 canopied boats must be fitted with a carbon-monoxide alarm.

508.25 Racing vest

Racing Vests - the efficiency of the racing vest is a matter of the exclusive responsibility of the wearer. Every crew member whilst on board, must wear a racing vest during the practice runs and throughout the race. Racing vests must be coloured high visibility orange or yellow. The racing vest must have epaulets/handles to help extract crew from the boat. The racing vest must have crutch straps or a method of ensuring that the vest does not “ride up”.

Guideline

Life vests should be of sufficient buoyancy to float the person with all racing gear on and also roll the person over, if face down in the water. This should be checked in a pool or benign situation before

racing and the jacket can be adjusted as necessary. Helmet restraints to limit extreme motion are recommended and are available for unrestrained participants.

508.26 Light

Each Reinforced Cockpit Area shall have one or more water activated light(s) or similar.

Guideline

Emergency light areas to focus attention (light next to hatches.)

508.27 Orange bow

All boats with restraints must have their bows painted fluorescent orange for at least 0.5m. Only boats with restraints and closed canopies are allowed to use orange coloured bows. If the hull is of a similar colour, then there must be a white separating band of at least 0.15 m wide to ensure that the fluorescent orange band is obvious. If the number of riding crew exceeds two, the number of riding crew members must be written in black in at least 0.25m high numbering on the orange nose in the following three locations:

- a) The lower running surface.
- b) The topside of the hull/sponson.
- c) The deck of the hull/sponson.

Should any boat be found to have contravened the riding crew number requirement, the penalty shall be disqualification from that event.

Note: Numbers shall be placed on the orange nose, not the white band area

508.28

It is mandatory that sufficient buoyancy is provided in the boat, or in the material used for its construction, to ensure that the boat floats if capsized or holed. If extra buoyancy is needed, the buoyancy system described by the designer should be verified by the Measurer. This added buoyancy must be in at least four separate flotation units.

It is recommended that the buoyancy should float the hull as parallel with the surface of the water as is practical, to help in rescue accessibility.

508.29 - CLASS 3 CRITERIA

Each National Authority shall decide if its National racing shall be permitted to use Restraint Systems in Class 3 boats below Class 3S/3S EPA.

In Class 3 boats, all the 508 rules apply. Refer to U.I.M. Offshore Rule 715.10 for application of flares. These flares must be readily accessible from the deck.

General

Scrutineering

Exterior Hull

Are there cracks in the gel-coat at the transom, other locations? What is the general appearance, age? Are drawings available (i.e. is the cockpit registered ?), Note the lay-up, condition of moldings and the shear line connection between the hull and deck, and that deck and hull fittings tight/well attached.

Interior Hull,

Are there cracks, water intrusion, oil/fuel intrusion? Note the condition of frames and gussets, steering mounts, trim mounts, air bottle mount, engine mounts/transom, connection/laminate between reinforced cockpit and hull, if applicable, cable runs-insulation in good condition, steering cables/hydraulic steering in good condition.

History of hull, any accidents? any damage?, repairs done, when?, modifications ?

730.2 - REINFORCED COCKPITS

Class 3S/3S EPA mono/multihulls first measured prior to 12th May 2007 must be equipped with a reinforced cockpit(s) for all riding crew members. The specification of which is as described in the 508 rules.

Class 3S/3S EPA mono/multihulls first measured after 12th May 2007 must be equipped with a reinforced cockpit(s) for all riding crew members. With the exception of the specific criteria listed below, the 508 rules apply in full.

Reinforced cockpits are permitted in any other category of Class 3, however, the following specification is the minimum mandatory standard for any reinforced cockpit used in any category of Class 3 boat.

Cockpit type:

The reinforced cockpit(s) shall be of a closed type design with a minimum of one opening hatch and constructed to a similar strength as the running surface of the boat.

Cockpit minimum size:

Hatch opening per person: 55 x **50** cm min.

Width: shoulder level 60 cm min.

Clearance: helmet to hatch 10 cm min.

Cockpit construction:

- Window to flanges joints must be glued and/or use bobbins of nylon or aluminium.
- Bolts: min 6 mm stainless steel, nylock nuts, washers.
- Bolt spacing: max. 10 cm if not glued
- The outer edges of the canopy surrounding the hatch, must be fitted with a water deflector, (height 10 mm min) to prevent water forcing open the hatch in the event of a capsized.
- Hatches must have a slot for pry bar use in emergency/rescue.
- Controlling crew must have clear visibility ahead with adequate panoramic view.

Window areas:

- Material: Polycarbonate or similar.
Glass (in any form) is specifically prohibited.
- Min thickness of window :
Side by side cockpits min 9.5 mm.
Screens with curvature and/or tandem cockpit min 7.9 mm

N.B. With the exception of the above specific criteria in this section, the 508 rules apply in full.

Guideline - Appendix

- *Cockpit registration form class 3*
- *Offsh.3 cockpit checklist*
- *M Lundblad sample Dimensions of Rollbars 3C*
- *M Lundblad sample material properties 2011.03*
- *S Hansen Cl.3 Cockpit consideration 2011.03*