Royal Ocean Racing Club
Rating Office

DRAFT RORCSTI1

RORC Safety and Stability Indices (SSI)

SSSN and ISO 12217 Part 2, STIX

Developed in Co-operation With The Royal Yachting Association

1. Preamble

To date, IRC and IRM certificates have incorporated a SSS Numeral for use by race committees in determining suitability of a particular boat for a race. SSS was developed as a collaborative venture between the RYA and RORC in the late '80s and has been in satisfactory use ever since. There are no technical grounds why its use should be discontinued now. SSS is however not accepted in many other parts of the world increasing the difficulty for owners in complying with race requirements. It is also highly desirable that the RORC makes use of the latest and most appropriate methods of stability and safety screening.

In developing the new ISO 12217-2, Small craft, Stability and buoyancy assessment and categorisation, Part 2, Sailing boats of hull length greater than 6 metres, the ISO working group has developed a stability index for assessing the stability and safety of sailing monohulls, known as STIX. STIX is a development of SSS, but uses more detailed stability data, including some from a righting moment curve. In addition to STIX, ISO 12217-2 includes separate requirements for minimum angle of vanishing stability (AVS). The latest technical requirements are given in ISO/FDIS 12217-2. However approximate methods for deriving certain parameters are only available in ISO/DIS 12217-2, which is an earlier version.

Full and immediate implementation of STIX to replace SSS would be difficult because of an absence of the required data for many, if not a majority, of boats. Considerable exploratory work has been carried out to explore whether satisfactory surrogate alternatives might instead be used but without real success.

In future therefore, each boat's certificate will continue to carry her SSS Numeral as currently, including if appropriate FSR. All boats that have been satisfactorily inclined for any purpose will in addition have STIX printed on their IRC/IRM certificates.

By this means, owners and race committees will continue to have SSS available to them but will at the same time have the option of STIX for more detailed assessment as required, albeit that some boats will require additional measurement.

It must be clearly understood that STIX, as printed on IRC/IRM certificates may **NOT** be pure STIX as defined by ISO/FDIS 12217. Except therefore in cases when STIX has been fully assessed by a Notified Body, the value printed will therefore be referred to as 'RORC STIX'. Conservative assumptions will be used as appropriate in the calculation of RORC STIX which will only be calculated by the RORC Rating Office. Only in cases when a full assessment has been carried out by a Notified Body will the term 'STIX' on its own be used.

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2. RORC Safety and Stability Indices (SSI)

RORC SSI derive from two roots: the previous RORC Safety and Stability Screening System (SSS) and ISO/FDIS 12217, Part 2, STIX. IRC and IRM certificates for each boat will continue to show an SSSN calculated in accordance with paragraph 2.1, SSSN. In addition, STIX or RORC STIX as appropriate, and either calculated or estimated angle of vanishing stability, will be shown for boats with qualifying measurements in accordance with paragraph 2.2 below. Race Committees may use either or both indices as qualifying parameters for races but are advised to follow the guidelines given by paragraph 3, Application of SSI by Organising Authorities.

2.1 SSSN

An SSS Numeral value, specific to that particular boat, is printed on each boat's IRC and/or IRM certificate issued by the RORC Rating Office. A high value indicates that the system evaluates a boat as being more seaworthy. SSSN is the sum of Base Value and Adjustment Value with the two values arrived at as follows.

The Base Value for the hull, rig and appendages is computed from the boat's dimensions and rated parameters. It is the product of several factors, each representing a different safety related feature. A Base Size factor, calculated from the boat's principal dimensions, is modified by each of the other specific factors to take account of variations from the norm. The modifying factors are: displacement/length, beam/displacement, sail area/displacement, beam/length, self righting, rig, keel, engine, and dayboat.

SSSN are calculated in accordance with the SSS routines held by the RYA and RORC. Variations (from the rules of the current scheme) that will be applied after 31st December 2001 are as follows:

2.1.1 IRC and IRM certificates will continue to show SSS Numerals for each boat, including as appropriate Self Righting Factor (FSR), but see 2.1.2 and 2.1.3 below.

2.1.2 FSR for uninclined boats is reduced from the previous 1.0 to 0.9 (*provisional*).

2.1.3 The provision for enhancement of base value by inclining the boat (see Appendix 1) to increase FSR to a maximum of 1.25 will continue with the following variations:

a) Stability data for boats inclined empty will be reduced by xx%.

b) Subject to 2.1.3 a), enhancement of FSR for One-Designs for which agreed standard stability data is available will continue as previously.

c) Upon application by an owner, enhancement of FSR will be extended to true sisterships of designs for which stability data is available. In this case, measured stability data will be reduced by xx%.

2.1.4 Adjustment Value (Table 1) allows for recognition of safety related features, principally compliance with a Category of ORC Special Regulations, not already evaluated by the rated parameters. Its application is optional and a zero value will be applied unless a request is made by an owner.

Table 1

Full compliance with	may be rewarded by Adjustment Value (unless restricted as shown by Table 2)
ORC Cat 4	+ 3
ORC Cat 3	+ 5
ORC Cat 2	+ 6
ORC Cat 1	+ 7
ORC Cat 0	+ 8

Owners may only apply for adjustment based on one of the above ORC Categories if the boat complies all the time when racing IRC/IRM. Alternatively, if the boat does not comply fully with any of the ORC Categories, adjustment for compliance with the specific features described on the application form below (Appendix 2) may be claimed. The maximum adjustment in this case is +3. A maximum limit determined by the calculated base value is imposed on the extent of adjustment, as shown by Table 2.

Table 2

Base Value range	Maximum Adjustment Value
less than 8	zero (no adjustment allowed)
8 - 14	+ 3
15 - 23	+ 5
24 - 32	+ 6
33 - 41	+ 7
more than 41	+ 8

2.2 STIX and RORC STIX

In a similar manner to SSSN, STIX or RORC STIX is a number representing the perceived 'seaworthiness' of the design, with again a higher value reflecting a more 'seaworthy' boat.

STIX may only be calculated using ISO/FDIS 12217-2, until this is superseded by ISO 12217-2. ISO/DIS 12217-2 will ONLY be used for the approximate calculation of downflooding angle and righting moment data for RORC STIX.

Each boat's RORC STIX is calculated in accordance with ISO/FDIS 12217 Part 2 STIX by the combination of factors related to dynamic stability, inversion recovery, knockdown recovery, displacement-length, beam-displacement, wind moment and downflooding, with the following additions and variations:

2.2.1 RORC STIX Numbers are calculated using declared or measured IRC and/or IRM data.

2.2.2 Each design shall be inclined in accordance with RORC procedures (Appendix 1) or by an RORC approved method. Stability data for boats inclined empty will be reduced by xx%. Exceptionally, when agreed by the RORC:

a) boats of approved one-design classes may use class standard inclining data.

b) true sisterships of designs already inclined may make use of sistership data. In such cases, stability data will be reduced by xx%.

2.2.3 Subject to approval by the RORC, a lines plan from any reasonable source may be used for the calculation of hydrostatic data.

2.2.4 Owners are responsible for the supply of righting moment data from a source acceptable to the RORC in the form required by ISO/FDIS 12217, Part 2, Paragraph 6.

2.2.5 In addition to RORC STIX, certificates for boats for which a hull offset file has been used in the calculation of righting moment data will show the *calculated* angle of vanishing stability

2.2.6 Designs for which a hull offset file is unavailable will have angle of vanishing stability, positive area under righting lever curve, and righting lever at 90^0 heel estimated by the approximate methods given by ISO/DIS 12217, Part 2, Annexes C.6, C.7 and C.8. In such cases, RORC STIX will show *estimated* AVS.

2.2.7 Downflooding angle, as used in the calculation of Downflooding Factor (FDF), is calculated in accordance with ISO/DIS 12217, Part 2, Annex B.

3. Application of SSI by Organising Authorities

3.1 Important Notice

Organising Authorities may incorporate a minimum qualifying SSSN value and/or STIX and/or RORC STIX for entry to a race. Responsibility for selection of which is to be used, for the minimum qualifying value(s), and for any AVS requirement(s), lies with the Organising Authority for a race. It is not possible for the RORC Rating Office, nor any other body remote from the organisation of a race, to lay down firm recommendations or guidance. Only the organisers of a race can be fully aware of the circumstances of a particular race.

3.2 SSSN or STIX or RORC STIX?

For many, if not a majority of races, SSSN will continue on their own to be an entirely valid method by which Organising Authorities may screen the suitability of particular boats for a race. When however there is doubt as to the suitability of a boat, or when Organising Authorities wish to apply more rigorous criteria, including in every case some direct knowledge of a boat's stability, STIX or RORC STIX may be used either additionally or as stand alone alternatives.

When STIX or RORC STIX are chosen, Organising Authorities may further require that each boat's certificate shall also show her calculated angle of vanishing stability (AVS). Calculated AVS is only shown when STIX or RORC STIX has been calculated using full righting moment data. In other words, approximations have not been made in the calculation of the various stability related STIX factors. Alternatively, in assigning requirements for a specific race, a minimum estimated angle of vanishing stability may also be specified, or no minimum AVS at all.

3.3 SSS Numerals

As examples only, the RORC typically uses the SSSN values shown in Table 3. There are however circumstances when the RORC will use different SSSN minima for a variety of reasons.

Table 3

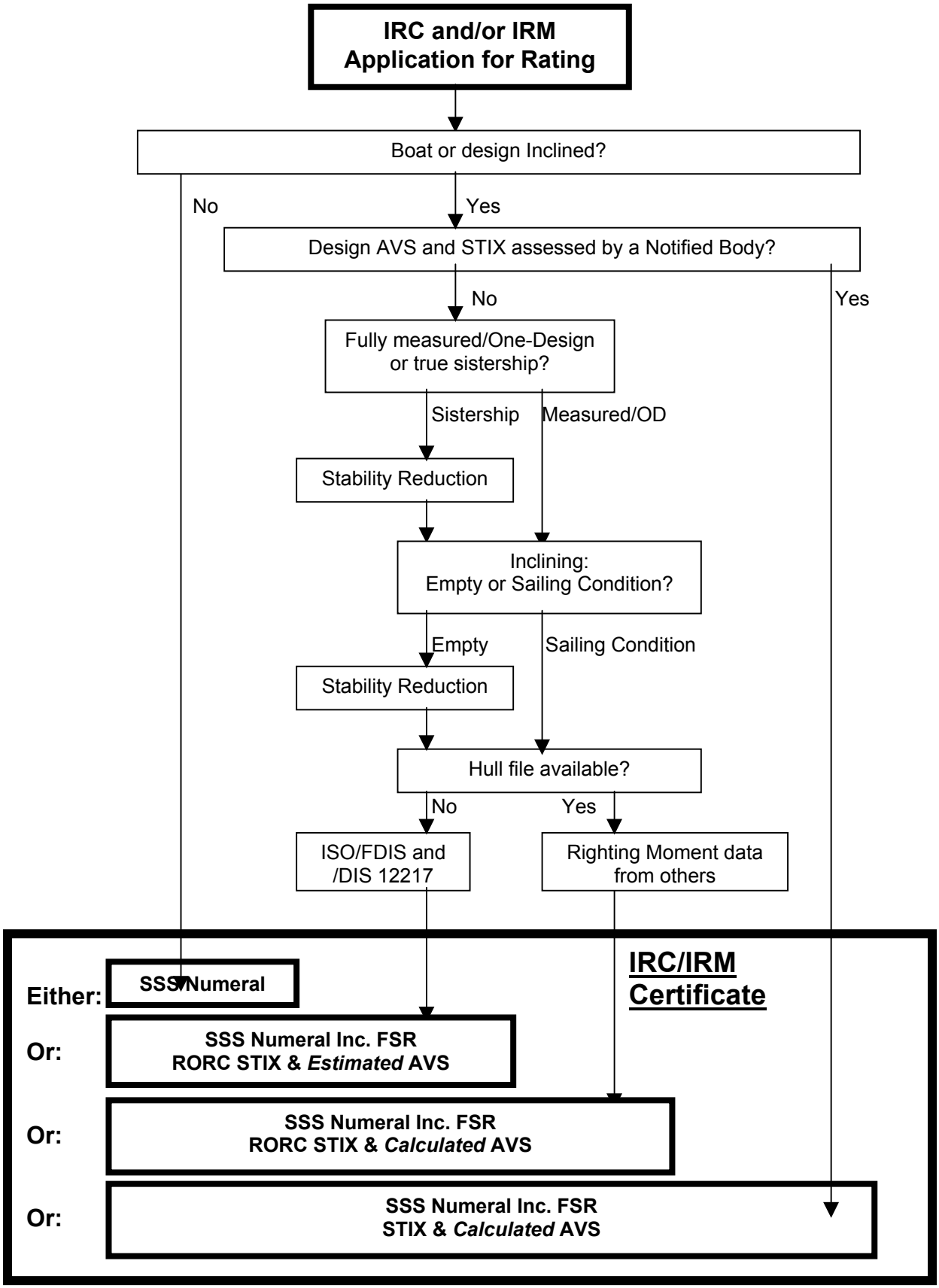
Minimum SSSN	Typical course	Example/ORC Race Category
10	Short day race usually with time limit	Typical Solent race/Cat 4
20	Passage race along or near populated coast	RORC cross Channel races/Cat 3
30	Between 250-600 miles	Fastnet Race/Cat 2
40	1000 miles in all weather	Plymouth to Gibraltar/Cat 1
50	2500 miles, continent to continent	Trans Atlantic race/Cat 0

3.4 STIX and RORC STIX

ISO/FDIS 12217 Part 2 defines 4 Design Categories and specifies minimum acceptable values of AVS for each as shown by Appendices 3 and 4. Table 4, below, shows the minimum STIX values associated with each Design Category. RORC STIX is directly compatible with STIX.

Table 4

Design Category	A	B	C	D
Minimum STIX:	32	23	14	5


IRC and/or IRM
Application for Rating
Boat or design Inclined?
No
Yes
Design AVS and STIX assessed by a Notified Body?
No
Yes
Fully measured/One-Design
or true sistership?
Sistership
Measured/OD
Stability Reduction
Inclining:
Empty or Sailing Condition?
Empty
Sailing Condition
Stability Reduction
Hull file available?
No
Yes
ISO/FDIS and
/DIS 12217
Righting Moment data
from others
IRC/IRM
Certificate
Either:
SSS Numeral
Or:
SSS Numeral Inc. FSR
RORC STIX & Estimated AVS
Or:
SSS Numeral Inc. FSR
RORC STIX & Calculated AVS
Or:
SSS Numeral Inc. FSR
STIX & Calculated AVS

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RORC Inclining For SSI

The purpose of the exercise is to measure RM as for a normal rating inclination. In this case however, the data is used to calculate the IOR stability screening variable sv. This value is in turn used by the SSSN software to calculate a self-righting factor, FSR. This is then a multiplier on SSSN base value, and can enhance base value by up to 25%. Additionally, the data is used as input data for the calculation of RORC STIX.

For reference, sv is to be found in Part XII of the IOR Rule. sv of c-1.5 and lower achieves the maximum permissible FSR of 1.25. In the case of an IOR measured yacht, all the relevant variables will already have been measured. For non-IOR yachts, various of these are required as well as the inclining data. These are:

1. Waterline Beam, BWL

By inspection, establish an approximate BMAX station and hang a plumb bob over each side. Measure BMAX and insets from the plumb lines to the local waterline beam. By subtraction from BMAX, BWL can be found.

2. Freeboard at BMAX station (IOR FMD)

Measure freeboards both sides.

3. Canoe Body Depth (IOR CMD, Centre Mid Depth)

This will normally be found from the designer supplied line plans or other data.

4. Waterline Length, LWP (IOR L)

Measure as for IRC, subtracting forward and aft overhangs from LOA.

The inclining is carried out exactly as for an IRM/IMS inclination, with the exception that the only freeboards required are those at the BMAX station (2. above).

The boat may be in either empty condition be in 'light' sailing trim with all gear and equipment necessary to race the boat. If in the light condition, water tanks must be empty, but small quantities of diesel are acceptable. Any in-mast or headstay furling sails should be hoisted and furled. Otherwise, the mainsail should be on the boom and other sails stowed below. The condition must be declared on the input sheet.

Environmental conditions are critical. There must be no current and an absolute maximum of 10 knots of wind, preferably less.

For boats which have not previously been inclined, the weight to be used will first have to be found. Assuming that four weights are to be used, set the boat up with poles out both sides, position and read the manometer, hang one weight on a pole and re-read the manometer. Manometer deflection (for a 1500mm manometer) should be in the range 18 to 22mm. Adjust the weight linearly to achieve this.

With the boat moored head to wind from a single bow painter, start with all 4 weights on one pole and transfer one at a time to the other pole, reading the manometer each time. Measure weight distance, with equal weight on each side.

Appendix 2

Application for an SSS Numeral Adjustment Value

APPLICATION for an SSS Numeral Adjustment Value

Boat name ..... Sail number .....

The allocation of an adjustment value is free of charge when sent at the time of initial application or annual revalidation. At any other time the appropriate RORC fee for an amended certificate should be included. *See ORC Special Regulations, available from the ORC, Ariadne House, Town Quay, Southampton, SO14 2AQ. tel 02380 632231 fax 02380 632167. They are also printed in the annual RORC (racing) programme and on the RORC website http://rorc.org.*

Boat conforms in all respects with ORC Category ..... (0, 1, 2, 3 or 4)

OR Specific adjustment features for boats not complying totally with the ORC Special Regulations requirements (tick those that apply. Maximum adjustment = 3)

.....i Self draining cockpit within ORC regs (3.6)

..... ii No cockpit lockers at all, or watertight or self draining cockpit lockers not extending below the cockpit sole.

..... iii Cockpit companionway closed to maindeck level and washboards to ORC Reg. 3.5.

.....iv All hatches and windows conforming to ORC Regs (3.3, 3.5 & 3.10(e))

.....v Full integral buoyancy capable of supporting the yacht and crew.

I, as the owner or representative of the above named boat, confirm that the identified features meet the requirements and that the boat and her equipment will remain at least to this standard when racing. If I make changes that are likely to reduce the applied SSS Numeral, I shall apply for a recalculation. I enclose the appropriate fee (if applicable).

Name ..... Signature ..... Date .....

If checked by an official, please ask them to sign here :

Name ..... Signature ..... Date .....

Appendix 3

ISO/FDIS 12217 Design Categories

Paragraph 8 of ISO/FDIS 12217 Part 2 defines four Design Categories as follows:

8 Application

8.1 Deciding the design category

*The design category for a particular boat is that for which it complies with **all** the requirements appropriate to the boat as required by clause 6 or clause 7.*

8.2 Meaning of the design categories

***8.2.1** A boat given design category A is considered to be designed to operate in winds of Beaufort force 10 or less and the associated wave heights, and to survive in more severe conditions. Such conditions may be encountered on extended voyages, for example across oceans, or inshore when unsheltered from the wind and waves for several hundred nautical miles. Winds are assumed to gust to 28 m/s.*

***8.2.2** A boat given design category B is considered to be designed for waves up to 4 m significant height and a wind of Beaufort force 8 or less. Such conditions may be encountered on offshore voyages of sufficient length or on coasts where shelter may not always be immediately available. Such conditions may also be experienced on inland seas of sufficient size for the wave height to be generated. Winds are assumed to gust to 21 m/s.*

***8.2.3** A boat given design category C is considered to be designed for waves up to 2 m significant height and a typical steady wind force of Beaufort force 6 or less. Such conditions may be encountered on exposed inland waters, in estuaries, and in coastal waters in moderate weather conditions. Winds are assumed to gust to 17 m/s.*

***8.2.4** A boat given design category D is considered to be designed for occasional waves of 0,5 m height and a typical steady wind force of Beaufort force 4 or less. Such conditions may be encountered on sheltered inland waters, and in coastal waters in fine weather. Winds are assumed to gust to 13 m/s.*

Table 8 — Summary of design category definitions

Design category	***A***	***B***	***C***	***D***
Wave height up to	*approx 7 m significant*	*4 m significant*	*2 m significant*	*0,5 m maximum*
Typical Beaufort wind force	*up to 10*	*up to 8*	*up to 6*	*up to 4*
Calculation wind speed (m/s)	*28*	*21*	*17*	*13*

8.2.5 The significant wave height is the mean height of the highest one third of the waves, which approximately corresponds to the wave height estimated by an experienced observer. Some waves will be double this height.

Appendix 4

ISO/FDIS 12217 AVS Minima

Paragraph 6.3.1 of ISO/FDIS 12217 gives the following minimum required angles of vanishing stability for each of the four Design Categories (see Appendix 3).

Required angle of vanishing stability

Design category	Required angle of vanishing stability ($\phi_{V(R)}$)
A	m > 3 000 kg, $\phi_{V(R)}$ = (130 - 0,002 m) but always ≥ 100°
B	m > 1 500 kg, $\phi_{V(R)}$ = (130 - 0,005 m) but always ≥ 95°
C	$\phi_{V(R)}$ = 90°
D	$\phi_{V(R)}$ = 75°

Where: m: Boat weight in kg
$\phi_{V(R)}$: Required minimum Angle of Vanishing Stability (AVS) in degrees

Examples of use.

1. Any boat with AVS equal to or greater than 75^0 satisfies the requirements for Design Category D.

2. Any boat with AVS equal to or greater than 90^0 satisfies the requirements for Design Category C.

3. The absolute minimum AVS for Design Category B is 95^0.

4. The absolute minimum AVS for Design Category A is 100^0.

5. A boat weighing less than 1500kg can never satisfy the requirements for Design Categories A or B.

6. A boat weighing less than 3000kg can never satisfy the requirements for Design Category A.

7. A boat weighing 5000kg has a required minimum AVS for:

   Design Category B of: $130 - 0.005 * 5000 = 105^0$

   and for Design Category A of: $130 - 0.002 * 5000 = 120^0$