ALTERNATIVE RSA MATERIALS

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APPROVAL PAGE

COMPILED BY:

NAME	e-mail address	POSITION	DATE	SIGNATURE*
C la Grange	CorrieL@dlsys.co.za	First Metallurgist	2017-07-27	APPROVED

RECOMMENDED FOR APPROVAL BY:

NAME	e-mail address	POSITION	DATE	SIGNATURE*
P Steyn	PieterS@dlsys.co.za	Systems Engineer: Platform	2017-07-26	Approved

ACCEPTANCE BY DLS PCPO:

NAME	e-mail address	POSITION	DATE	SIGNATURE*
LJ Lubbe	LouisL@dlsys.co.za	Systems Engineer	2017-07-27	APPROVED
JC du Toit	jcdutoit@dlsys.co.za	Snr Manager Programme Assurance	2017-07-27	Approved
S Pillay	ShamendranP@dlsys.co.za	Programme Manager: HOEFYSTER	2017-07-31	Approved
SM Malatjie	SetshubeM@dlsys.co.za	ILS Manager	2017-07-26	Approved

* This document was accepted using “QUICKLY SIGN” of which an audit page is attached at the end of this document.

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1 ALTERNATIVE RSA MATERIALS

1.1 BACKGROUND INFORMATION

Patria has been solicited to allow for material changes for the Badger vehicle on certain components to assist in local procurement. The typical limitations are that the South African material equivalent in yield strength properties have not been certified to minus twenty degrees Celsius (-20° C). This is typically so for the S355K2G3 in its various flat – and long-steel product ranges. Other material options are available to different standards but are for all practical purposes equivalent. Speciality steels such as the armour plate and hard-wearing steel plate are not at issue.

Denel Land Systems (DLS) has reacted on requests from various sub-contractors and have investigated and evaluated alternatives proposed by them; or offered other options as alternatives, which are presented in the following tabulated paragraphs.

The viable alternatives offered are as close as possible to the specified material in terms of yield strength. This is to minimise the possibility of creating fabricated modules with excessive "stiffness" that could drastically affect the ability to deform under extreme loading, thereby compromising the design.

- This is in spite of the alternative options with higher strength originally proposed, having good impact toughness properties (at least equal to the higher quality required from the S355K2 option); and being manufactured to standards possibly superior to S355K2G3 in having reduced – and calcium modified – sulphur/ sulphide content; as well as fine-grain practices.

Indications are that a particular concern of PATRIA is that the minimum bending radii of alternative materials could hamper the manufacturing ability of the cold-formed components if they are not small enough; or that these could induce residual stresses that might be detrimental from a fatigue point of view when they are in fact bent to certain minimum radii.

- In this regard, the datasheet of the SSAB alternatives indicating minimum radii are compared with the main flat-steel quality, the S355K2G3 (or S355 K2 +N as is the current designation. The latter steel does not seem to have manufacturer-specific datasheets in this regard, and therefore the EN 10025–1:2009 is used to get an indication (specifically Table 13 – "Cold roll forming of flat products" for plate thicknesses up to 8 mm; and extrapolating from Table 12 – "Minimum recommendations of the bend radius for cold flanging of flat products" for plate thicknesses from 8 mm up to 30 mm.
- The alternative flat product that is nearest in terms of yield strength, is potentially only available in thicknesses up to 15 mm (SSAB DOMEX 420 MC). Therefore, as a comparator, the SSAB STRENX 700 is used. This is the hardened and tempered version of which the impact toughness is very good, but is not proposed as a replacement option. (SSAB DOMEX 460 MC is also used for purposes of comparison.)

The option of recertifying the S355 type steel products which have not been certified to the S355K2G3 (S355K2 +N) quality, is also offered. This will be done on individual products, as is the requirement imposed on S355K2 +N in EN 10025–1:2009. This will be based on the impact energies absorbed at a testing temperature of minus twenty degrees Celsius (-20° C), as indicated in EN 10025–1:2009.

- The option of additional heat treatment of S355 material is a valid option to increase the impact fracture toughness properties at sub-zero temperatures, **especially when material has been cut to the smaller thicknesses/ widths when nested from the**

mother plate. The typical heat treatment will be by; austenitising at 880 - 900°C; oil quenching; and then tempering in the temperature range 550 – to 650°C (upper strength limit at lower tempering temperature).

- Additional requirements of fracture appearance on the fracture surfaces of the fractured V-notch impact samples will be implemented. This will typically require ductile fracture features of the order of 50-percent ductility.
    - The fracture feature requirement is partially based on the requirement that the manufacturing process for the S355K2 +N must be industrialised by plotting ductile-to-brittle fracture transition curves along with the impact toughness values achieved (Joule).
    - It also allows the ASTM E 23 Charpy v-notch impact test to be used instead of the EN 1045–1 and –2 standard, which might differ in the actual joule values achieved. Using fracture appearance criteria will also assist in allowing for variable refining, albeit that testing is to be in the longitudinal direction, which should minimise that influence.

The PATRIA datasheets will not be altered, but this DLS document is generated to allow for alternatives to be used where deemed not to compromise the integrity of a component.

Finally, using criteria which will ensure that minimum impact toughness properties are attained at -20° C, which is the temperature to which the Badger vehicles need to be guaranteed in terms of being safe, but would not typically be attained – and specifically by using fracture appearance criteria as well, can be justified on a technical basis.

The following tabular format records the alternatives requested, with additional explanatory notes and comparative tables, where applicable.

2 ALTERNATIVE MATERIALS DEFINITION

Table 1: SUBSTITUTE MATERIALS FOR LOCAL PRODUCTION / AMV RSA2

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
1	Request number 1. Covers all S355K2G3 materials specified on the PATRIA STANDARD 93270 S355K2G3 [Current Standard: S355K2 +N to EN 10025-: 2009]Note A	D000095_C Standard – 93270 Note A	1. SSAB DOMEX 420 MC or **direct equivalent** Tradename material, which guarantees directly equal toughness and ductility properties. Refer Note A and Table A 2. Recertified S355JR/ -J0/ and –J2 by means of doing Charpy V-Notch impact tests at -20° Note B.	Note A) The thicknesses of the plates as per PATRIA Standard 93270, are tabulated in the following row, along with the minimum bending radii enforced on the alternative material. The bending criteria of the S355K2 +N are from EN 10025–1; 2009; and that of the DOMEX 420 MC from the SSAB datasheet. Note B) Acceptance will be based on impact energy values achieved as indicated as minima in EN 100250–1:2009. Additional criteria will be fracture appearance properties of the impact fracture surfaces of the samples. The desired properties will be ductile fracture properties of the order of at least 50-percent of the surface fracture area. (Typical examples are illustrated as follows [varying plate thickness – non-standard impact samples for initial screening purposes] – 100% ductile fracture surfaces on outer samples.)

Thickness mm	Minimum bend radii S355K2C EN10025-2:2009	Minimum bend radii DOMEX 420 MC 2) Bending radii are guaranteed in all directions regarding the direction of rolling.	Minimum bend radii S355K2C SANS50025-2:2009
2,5 3 4			
5	2,50 mm	1.00 mm	2,50 mm
6	3.00 mm	1.20 mm	3.00 mm
8	4.00 mm	2.00 mm	4.00 mm

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
	10 12 15 16 20 22 30	7.50 mm	2.50 mm	7.50 mm
		9.00 mm	3.00 mm	9.00 mm
		12.00 mm	6,40 mm	12.00 mm
		20,00 mm 1)	8,00 mm	20,00 mm 1)
		25,20 mm 1)	9.60 mm	25,20 mm 1)
		33.50 mm 1)	12.00 mm	33.50 mm 1)
		36,00 mm 1)	Not available	36,00 mm 1)
		50,00 mm 1)	Not available	50,00 mm 1)
		57,20 mm 1)	Not available	57,20 mm 1)
		80,00 mm 1)	Not available	80,00 mm 1)
2	94891-01001	D000101_G	1. Stainless steel 304 (condition 2B)	Material certificate will refer to 304/2B and not 1.4301 as per Patria Data Sheet
3	S275J2H Square Tube (20x20x2mm)	D000090_A	1. ASTM A500 Grade B	The steel is S275J2H to EN 10219-1, and specifically Cold Formed Square or Rectangular Hollow Section (CFRHS). This has the following requirement, namely: a) Yield strength of 275 MPa; b) 27 Joule Impact strength at -20° C; c) Is cold drawn to ensure the strength as well as the dimensional and surface finishes. The thicknesses are typically of the order of 2– to 4 mm, which should ensure that the majority of cold-workable, low carbon steel tubes would be ductile throughout their thicknesses by means of impact loading. The Grade B to ASTM 500 requested, does not require any impact properties, but as indicated, the reduced thickness should allow for an *'artificial'* addition to impact toughness [Plane Stress Conditions], which should reduce the ductile-to-brittle transition temperature. Based on the thickness, it should be acceptable.
4	IMATRA	D000073_B	EN14A	a) IMATRA 550 is a S355J2

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
	550/500 Solid Round Bar [550 refers to UTS; and 500 refers to Yield Strength, both being the same material requirement.]	PATRIA STANDARD 93055	1. Harden and Temper S355JR/ –J0/ or –J2 steel. 2. Cold work S355J2 grade steel to the required properties. 3. PATRIA stock, shipped with other material requirements. 4. **070M20 to BS 970, Part 1, 1983; - Quench hardened in saturated brine (salt/ water solution) quenching medium. Refer (f).**	to EN 10025-2:2004 grade steel, cold-drawn (S355J2+C) to EN 10277-2:2008. b) The S355 J2 is capable of being hardened and tempered to achieve (or approach) the required yield strength of the IMATRA 550, which is of the order of 500 MPa. c) It could be possible that even the S355JR will be able to be treated in this manner and gain good impact properties. d) A gain in the quality of impact properties should be achievable with a refinement in structure over that of the as-rolled material. e) Indications are that solid bars in any of the S355 grade steels; as well as the En 14A (150M19/ 150M28, to BS 970, Part 1, 1983) are not (readily) available in South Africa. [The latter only being available from diameter >75 mm.] **f) Quench-hardening in a brine quenching medium (saturated salt/ water solution) and Tempering will give additional strength and *impact toughness.* This is particularly so if this is done in cut lengths and specifically in the order of Ø30 mm.** **g) Cold drawing could be applied if water-quenching can be done in significant lengths, but will require minimum tonnages.**
5	Aluminium 5754 H14	D000098_E Patria Standard	1. Aluminium 5754 H22 2. Any 5-series H14 – to	1) Patria footnote [1)] indicates that the H14 Temper is to

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
	Aluminium 5754 H22 Aluminium 5754 H32 Aluminium 5754 0/H111 As per EN 485-2	93325	H34. Refer to tabulated material options below. 3. Where strength can exceed specified requirement (i.e. no bending requirement) 6-series aluminium will be used.	be avoided where possible because of poor availability. This would indicate that this request has been dealt with. 2) Hard anodising of parts after manufacturing (including welding) is requested. This would seem to deal with the note under paragraph 3 of Standard 93325 that "Due to the danger of corrosion, the weld must be carefully cleaned of welding residue". The anodising will also serve as adhering layer for any subsequent paint/ coating that is required. Alternatively the Alodine or Alchrome processes ensuring under-coating corrosion resistance can be considered. 1) "Availability of H14-state aluminium as a stock product isn't good. This concerns especially plates with low thicknesses. Use H14-state aluminium with discretion, for example only when strength requirements demand it. Otherwise use H22/ H32 or)/ H111 – state aluminium."
	PATRIA Std. 93325 refers to five Temper conditions which are as follows: a) Temper H14, which is work-hardened to half-hard and not annealed after being cold-worked; b) Temper H22, which is work-hardened and partially annealed to quarter hard condition; c) Temper H32, which is work-hardened and stabilised by low-temperature heat treatment to quarter hard; d) Temper 0, which is fully annealed to a soft condition; e) Temper 111, which has some work hardening imparted by shaping and forming processes, but less than the H11-Temper, which indicates a better defined strain-hardening by shaping, but H11 is not clearly defined as to how much this straining might be (probably at the limit of form-straining allowed by the material before tearing, but this definition is rather vague.) **Some 5000 series options are as follows (but Manufacturer(s) must indicate which are the most likely candidates:**			

OPTION NO.	SOME 5000 SERIES AND 6000 SERIES OPTIONS ARE REPORTED.	THICKNESS	TENSILE STRENGTH	PROOF STRENGTH
5.1	Aluminium Alloy 5005 H34 sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 12.50 mm thick (*aalco®*)	145 – 185 MPa	110 MPa Min.
5.2	Aluminium Alloy 5052 H32 sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 6.00 mm thick (*aalco®*)	210 – 260 MPa	130 MPa Min.
5.3	Aluminium Alloy 5083 0/ H111 sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 6.30 mm thick (*aalco®*)	275 – 350 MPa	125 MPa Min,
5.4	Aluminium Alloy 5083 0/H111 Plate BS EN 485-2:2008, as per *aalco®*	6.30 mm to 80.00 mm thick (*aalco®*)	270 – 345 MPa	115 MPa Min,
5.5	Aluminium Alloy 5083 H32 Sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 6.00 mm thick (*aalco®*)	305 – 380 MPa	215 MPa Min,
5.6	Aluminium Alloy 5083 H32 Plate; ASTM B209-14 (2014)	3.18 mm to 76.20 mm thick (*aalco®*)	305 – 380 MPa	215 MPa Min,
5.7	Aluminium Alloy 5251 ‘0’ Sheet and Plate; BS EN 485-2:2008, as per *aalco®*	0.20 mm to 50.00 mm thick (*aalco®*)	160 – 200 MPa	60 MPa Min,
5.8	Aluminium Alloy 5251 H22 Sheet and Plate; BS EN 485-2:2008, as per *aalco®*	0.20 mm to 25.00 mm thick (*aalco®*)	190 – 230 MPa	120 MPa Min,
5.9	Aluminium Alloy 5251 H24 Sheet and Plate; BS EN 485-2:2008, as per *aalco®*	0.20 mm to 12.50 mm thick (*aalco®*)	210 – 250 MPa	140 MPa Min,
5.10	Aluminium Alloy 5251 H26 Sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 6.00 mm thick (*aalco®*)	230 – 270 MPa	170 MPa Min,
5.11	Aluminium Alloy 5454 H22/ H32 Sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 6.00 mm thick (*aalco®*)	250 – 305 MPa	180 MPa Min,
5.12	Aluminium Alloy 5454 ‘0’/ H111 Sheet BS EN 485-2:2008, as per *aalco®*	0.20 mm to 6.00 mm thick (*aalco®*)	215 – 275 MPa	85 MPa Min,

5.13	Aluminium Alloy 5086 '0' Sheet and Plate ASTM B209-14 (2014)	0.50 mm to 50.0 mm thick. ASTM B209-14	275 – 350 MPa	95 MPa Min,
5.14	Aluminium Alloy 5086 H32 Sheet and Plate ASTM B209-14 (2014)	0.50 mm to 50.0 mm thick ASTM B209-14	275 – 325 MPa	190 MPa Min,
5.15	Aluminium Alloy 6082 '0' Sheet; BS EN 485-2:2008, as per *aalco®*	0.40 mm to 6.0 mm thick (*aalco®*)	150 MPa Max.	85 MPa Max.
5.16	Aluminium Alloy 6082 T6/ T651 Sheet; BS EN 485-2:2008, as per *aalco®*	0.40 mm to 6.0 mm thick (*aalco®*)	310 MPa Min.	260 MPa Min.
5.17	Aluminium Alloy 6082 T6/ T651 Plate; BS EN 485-2:2008, as per *aalco®*	6.0 mm to 12.5 mm thick (*aalco®*)	310 MPa Min.	255 MPa Min.
5.18	Aluminium Alloy 6082 T6/ T651 Plate; BS EN 485-2:2008, as per *aalco®*	12.5 mm to 100.0 mm thick (*aalco®*)	295 MPa Min.	240 MPa Min.
5.19	Aluminium Alloy 6082 T6/ T651 Plate; BS EN 485-2:2008, as per *aalco®*	100.0 mm to 150.0 mm thick (*aalco®*)	275 MPa Min.	240 MPa Min.
5.20	Aluminium Alloy 6061 '0' Sheet/ Plate; ASTM B209-14 (2014)	0.15 mm to 25.4 mm thick ASTM B209-14	150 MPa Max.	80 MPa Max.
5.21	Aluminium Alloy 6061 T4 Sheet; ASTM B209-14 (2014)	0.15 mm to 6.3 mm thick ASTM B209-14	150 MPa Max.	80 MPa Max.
5.22	Aluminium Alloy 6061 T451 Sheet; ASTM B209-14 (2014)	6.35 mm to 25.4 mm thick ASTM B209-14	150 MPa Max.	110 MPa Max.
5.23	Aluminium Alloy 6061 T42 Sheet; ASTM B209-14 (2014)	0.15 mm to 25.4 mm thick ASTM B209-14	150 MPa Max.	95 MPa Max.

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
6	Aluminium EN AW 5754 H111 (Addressed in 5.3; 5.4	D000098_E Patria Standard 93325	Aluminium 5035 or – 5085 to H22	Hard anodise parts after manufacturing. 1) EN 485-2 does not reference 5035 or 5085, but 5083 or 5086, Please

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
	and 5.13)			advise which grades are offered and to which standard.
7	Aluminium tread plate EN AW 5754 H114	Patria T-Sheet T000164_0	EN AW 1200 Or EN AW 1050	Hard anodise parts after manufacturing. 2) Hard anodising of parts after manufacturing (including welding) is requested. This would seem to deal with the note under paragraph 3 of Standard 93325 that “Due to the danger of corrosion, the weld must be carefully cleaned of welding residue”. The anodising will also serve as adhering layer for any subsequent paint/ coating that is required. Alternatively the Alodine or Alchrome processes ensuring under-coating corrosion resistance can be considered.
8	9SMN28K (Material. No. 1.0715	D000071_A Patria Standard 93040	BS 970, Part 1, 1983 – 220M07 (En 1A)	Material is a resulphurized free-cutting steel. Advised to us as an alternative.
9	E235+N to EN 10305-4 “Precision Steel Tubes-Seamless”	D000086_L Patria Standard 93201, Rev. L	1. S355JR (refer adjacent notes in terms of refining, etc.) 2. S355JR Recertified to K2G3	The specified materials are galvanised seamless precision steel tubes for hydraulic and pneumatic (air) pressurised tubes. The standard to which these are specified, is EN 10305-4: *Steel tubes for precision application – Technical delivery conditions –Part 4 – Seamless cold drawn tubes for hydraulic and pneumatic power systems.* Specific requirements are: A) Fully killed steel, with B) Carbon content limited to 0,019-percent on product analyses (0.015 on cast), and; C) Sulphur content to 0,018 on product analyses (0,015 on cast). The latter would indicate that improved ductility/

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
				toughness is required in the transverse direction. C.1 Furthermore, it is noted that the intrinsic impact values are 27 Joule at 0° C. C.2. Based on the application, the S355JR would not be deemed desirable for the application; and the –J2 or ideally the –K2 quality should at least be considered if the original material cannot be sourced. **However, S355JR often is manufactured to more restricted chemical analyses, and could be found suitable when tested (re-tested).**
10	RAEX 355 MC OPTIM	1. T001208_A 2. T001209_A 3. T002984_A	1. SSAB DOMEX 355 MC 2. SSAB DOMEX 420 MC	a) The SSAB DOMEX 420 can be bent to 0.4 x t, which gives a minimum bending radius of 1,20 mm instead of 0,7 mm of the RAEX 355 MC OPTIM. The bending directions of the DOMEX 420 MC are in all directions – as it is for RAEX 355 MC OPTIM. The SSAB DOMEX 355 MC has a minimum bending radius of 0.2 x t, which is 0.6 mm – indicating the level of refinement applied to the SSAB product. b) If the slightly larger minimum bending radius can be accommodated in the application, this must be considered acceptable. Possibility that SSAB could supply original material under investigation.
11	RAEX 355 HSF	93270-06006	1. SSAB DOMEX 355 MC 2. SSAB DOMEX 420 MC	No problem foreseen with alternatives offered.

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
12	E295K, EN 10025-2:2004. Cold drawing increases yield strength pending thickness	D000075_A Patria 93062	1. S355JR recertified to S355J0; or S355J2/ or –K2. 2. 070M20 to BS 970, Part 1, 1983 (Hot-rolled/ normalised and lightly cold drawn)	a) The material specified achieves 295 MPa in the smaller diameters by hot-rolling. The material allows for cold drawing to increase the yield strength, but Patria 93062 indicates that this is not taken into account. The nomenclature “Cold Drawn” is probably only for finishing purposes. b) There are no impact requirements specified, so the S355J0 should allow for any bending requirements and compensate for an increase in yield strength. c) A contractor requested using 070M55 to BS 970, Part 1, 1983 (En9) in bright bar. This is not recommended because the high carbon content poses difficulty and increased risk in welding; and will have extremely poor impact properties, even at room temperature and temperatures above.
13	S355J0	D000074_C Patria STD 93060 D000084_E Patria STD 93160	1. Recertify S355JR if S355J0 cannot be sourced. S355J0/ –J2/ and – K2 if available will automatically qualify. 2. **070M20 to BS 970, Part 1, 1983; - Quench hardened in saturated brine (salt/ water solution) quenching medium and tempered at 560° C and above. Refer (c).**	a) Impact fracture surface appearance should at least indicate 50-percent ductile fracture area at 0° C (zero degrees Celsius). b) A contractor requested using 070M55 to BS 970, Part 1, 1983 (En9) in bright bar. This is not recommended because the high carbon content poses great difficulty in welding and will have extremely poor impact proper-ties, even at room temperature and above. c) Quench-hardening 070M20 to BS 970, Part 1, 1983; in water saturated with table-salt (saturated brine solution

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
				[or 10-percent brine solution]), gives improved strength and impact toughness properties within certain dimensional limitations, and will replace the S355J0 with no compromise on toughness properties imposed.
14	OPTIM 700 MC PLUS RAEX 650 MC OPTIM	D012664_C Patria STD93272	1. SSAB STRENX 700 MC. 2. SSAB STRENX 700E 3. STRENX 650 MC (DOMEX 650 MC)	a) Patria indicates that as of 17-12-2012, only OPTIM 700 plates are to be used. However, there has been a request to retain the RAEX 650 MC OPTIM, but the SSAB STRENX 700 MC will give the desired toughness and bending ability required. b) The STRENX 700E will give 69 Joule at -40° C, which will be more than adequate as a replacement for the OPTIM 700 PLUS, where this is deemed to absolutely necessary. c) Where the bending minimum radii are required, the SSAB STRENX 700 MC will be equal to the OPTIM 700 MC PLUS.
15	RAEX 550 MC OPTIM	T000995_0 Part Number 001506_0	1. DOMEX 550 MC 2. STRENX 700 MC	1. Bending radii is acceptable. 2. **Ensure that minimum internal bending radii required for the parts manufactured are accommodated by the minimum radii enforced for the STRENX 700 MC (DOMEX 700 MC)** if this is used as an alternative.
16	DC01 AM to EN 10130 (M = Thermomechanically	D000094_B Patria STD93260	1. S275JR 2. Mild Steel 3. DD14 to EN 10111, ‘Drawing and Forming	1. When using commercial mild steel, carbon content should be less than 0.25-percent. It must also be restricted to non-critical

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
	Rolled; and A = Soft Annealed)		Grades.'	applications such as inspection covers, etc., unless the ductility and toughness has been established. 2. Using DD14 to EN 10111 is superior to DC01 AM to EN 10130
17	1.4301	D000097 Patria STD93310	SAE 304/ AISI 304	Conform to required material albeit to different suppliers and standards. Grades are generic.
18	1.4404 JA	D000097 Patria STD93310	SAE 316L/ AISI 316L	Conform to required material albeit to different suppliers and standards. Grades are generic.
19	1.4462	D000097 Patria STD93310	SAF 2205 (SANDVIK) X2CrNiMoN 22-5-3	No problem, specified material available (SANDVIK)
20	1.4301 2B	D000097 Patria STD93310	SAE 304 2B (or direct equivalent)	Conform to required material albeit to different suppliers and standards. Grades are generic.
21	1.4305	T001419_0 Part Number 001914_0	SAE 303/ AISI 303	Conform to required material albeit to different suppliers and standards. Grades are generic.
22	SS 2331-43	T006547_0 Part number 007251_0 and T006550_0 Part number 007253_0	SAE 301/ AISI 301	Full Hard-drawn
23	SS 1770-04	T004275_0 Part number. 004746_0	1. AISI 1070 steel	1. AISI 1070 can be hardened and tempered between plates to ensure flatness. 2. Contractor requested AISI 301 –Full Hard Drawn; of which their supplier in South Africa (STRARCO) indicate that the function will be retained, but yield and tensile properties are considerably lower in this case.
24	42CrMo4 (Q+T)	D000099_C PATRIA	1. 709M40 to BS 970, Part 1, 1983 (or as it is also known–En19)	Great care must be taken to have the material well hardened and tempered by

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
		STD94732 C		**applying an effective austenitising and liquid-quenching (at least in oil) hardening cycle [Q = Quench Hardening]; and then tempering at an appropriate tempering temperature (550°- to 660°C) [T = Tempering, i.e. Q+T]. This is essential to achieve the desired toughness properties**. This specifically necessary if these components are to be liquid-nitrated and blackened. [The Tufftride and AB1 quench (followed by polishing and re-quenching in AB1 if necessary to get a polished finish.) This is the so-called QPQ process.
25	St 52	D000088_C PATRIA STD93206	1. S 355JR/; -J0/; -J2	No specific impact requirements seem to be implemented.
26	S235JRG2	D000076_B	2. S235JR offered	No deviation
27	Aluminium EN AW 6082 T6/ Hexagon 22mm	Patria T-sheet T001818_0		Alternatives – if any – are to be determined in terms of availability in RSA. 1) Hard anodise parts after manufacturing. 2) Hard anodising of parts after manufacturing (including welding) is requested. This would seem to deal with the note under paragraph 3 of Standard 93325 that “Due to the danger of corrosion, the weld must be carefully cleaned of welding residue”. The anodising will also serve as adhering layer for any subsequent paint/ coating that is required. Alternatively the Alodine or Alchrome processes ensuring under-coating corrosion resistance can be considered.

NO.	PATRIA SPECIFIED MATERIAL	PATRIA T-SHEET	DLS PROPOSED MATERIAL	NOTES
28	Aluminium EN AW 6082 T651/ T62 Plate- 40 mm	Patria T-sheet T001508_0		Alternatives – if any – are to be determined in terms of availability in RSA.
29	No specific notes or requests are attached to the specialised high strength/ specific property requirement steel, such as HARDOX 400 and ARMOX 550T, or their equivalent Commercially Branded options that might be available. This is because these are critical in the protection of the crew. Where alternatives are available which are **equal** to the benchmark established by the benchmark *SSAB* ARMOX and – HARDOX brands, this could be considered. Using alternatives is however, unlikely.			

Table 2: SUBTITUTE MATERIALS FOR LOCAL NON-METALLIC MATERIAL

01	Chloroprene CR 15	T001880_0	Neoprene 25 SONDOR INDUSTRIES (PTY) LTD pta@sondor.co.za; jhb@sondor.co.za; www.sondor.co.za;	1. The density of the CR 15 in the datasheet T001880_0 is indicated to be 0.50 - 0.80 Mg/m^3 (Megagram/m^3). **This equates to 500 – to 800 kg/m^3.** 2. A typical Cellular Rubber Plate (Type: RCT® - CHAP-1021-3 **with directly equivalent Shore hardness of 15° ± 3° and directly equivalent temperature properties of the specified CR15 material**) has a density of 0.21 g/cm^3 (0.21 Mg/m^3 **or 210 kg/m^3**) [www.rct-online.de/en/semi-finished-products/plates/foam-rubber-plate-made-of-cr-shore-150; Reichelt Chemietechnik GmbH + Co]. 3. The alternative **(Sondor Neoprene 25)** offered has a density of **150 – 200 kg/m^3**, which approaches that of the typical alternative indicated in (2); but with Shore hardness 38° - 55°. 4. Neoprene is considered to be a different nomenclature for Chloroprene, and is considered equivalent where the other properties are of the same order of magnitude. 5. The differences in densities between that indicated in the PATRIA datasheet and that indicated under paragraph (2) and (3), must be taken cognisance of in the application considered.

				6. The higher Shore hardness of the SONDOR Neoprene 25 will give better abrasive resistance than the CR 15.

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