CHOCKFAST Calculation Sheet
Mounting Area & Bolt Torque in SI Units

Shipyard / Company:		**Prepared For:**	Alan McKechnie
Vessel / Facility:	CCGS Samual Risley	**Company:**	Altec
Classed By:	Transport Canada	**Prepared By:**	Jim Kuly
Location:		**Date Prepared:**	10/13/2006
Machinery Type:	Main Engine	**Make & Model:**	Warsila VASA 12V22HF
Total Deadweight:	14,515 kg DWT		Including water, oil, fuel and accessories.

Foundation Bolts:

	Quan	Size	Type Bolt	Grade	Nominal Dia D_n (mm)	Tensile Stress Dia D_{ts} (mm)	Pitch Dia D_p (mm)	Comments
1	2	M20	Fitted	8.8	20	17.7	18.4	Type in the quantity, size, type and grade of bolt that intrudes into the Chockfast. Do not include a bolt if it does not penetrate the Chockfast. It is a good practice to design the chocks so that jacking bolts do not go into the Chockfast.
2	12	M20	Clearance	8.8	20	17.7	18.4	
3	4	M16	Jacking		16	14.1	14.7	
4								
5								
6								
7								
8								
TNB	14	Clearance or Fitted Bolts						

Mounting Plate Bolt Holes:

	Quan	D (mm)	Type Hole	Area / Bolt (mm^2)	Total Area	Units	Comments
1	2	34	Fitted	908	1,816	mm^2	Type in the quantity, size and type of hole in the equipment's mounting pad. This may or may not be equal to the bolt's clearance or shank diameter.
2	12	34	Clearance	908	10,895	mm^2	
3	4	16	Jacking	201	804	mm^2	
4				-	-	mm^2	
5				-	-	mm^2	
6				-	-	mm^2	
7				-	-	mm^2	
8				-	-	mm^2	
				Total Bolt Area:	13,515	mm^2	

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		Quan	L (mm)	W (mm)	Area / Chock (mm^2)	Total Area	Units	Comments
Chock Area:	1	2	375	86	32,250	64,500	mm^2	Enter the quantity length and width of all the chocks. Make sure you include only that area covered by Chockfast and directly beneath the equipment mounting pads. **Good design practice suggest a maximum chock length of 457 mm (18 inches) or a maximum length to width ratio of 4:1. Also, there must always be at least one bolt per chock. The bolt hole wall thickness must be at least (4 x Hole Dia +1) / 8.**
	2	10	340	86	29,240	292,400	mm^2	
	3	2	245	86	21,070	42,140	mm^2	
	4				-	-	mm^2	
	5				-	-	mm^2	
	6				-	-	mm^2	
	7				-	-	mm^2	
	8				-	-	mm^2	
	TCA				**Total Chock Area:**	399,040	mm^2	
	BHA				**Less Total Bolt Hole Area:**	13,515	mm^2	
	ECA				**Effective Chock Area:**	385,525	mm^2	
	MCA				**Minimum Chock Area:**	207,206	mm^2	
			There is ADEQUATE Chock Area for this equipment.					
Deadweight Loading:	DWL = (Deadweight (kg) x 9.81 N/kg) / Effective Chock Area in N/mm^2						N/mm^2	Deadweight Loading (DWL) is limited by class societies to between 0.6865 - 0.9926 N/mm^2 (7 - 9 kgf/cm^2) for precisely aligned equipment.
	DWL =		14,515 kg x		9.80669 N/kg /	385,525	mm^2	
	DWL =		0.369 N/mm^2		< 0.9926 N/mm^2		**The DWL is OK**	
Design Total Static Loading:	DSL		**4.41** N/mm^2 @ 80 °C		Must be between 3.43 - 4.41 N/mm^2 for precisely aligned equipment (500 - 640 psi)		N/mm^2	The Design Total Static Load (DSL) is the max load allowed on the chocks and includes both Deadweight load and Bolt Tension. It must be in the range of 3.43 - 4.41 N/mm^2 (35 - 45 kgf/cm^2) for class approval of precisely aligned equipment. For all other equipment, loading is limited to 8.29 N/mm^2 (84.5 kgf/cm^2) for CF Orange and 5.52 N/mm^2 (56.3 kgf/cm^2) for CF Gray. Intermittent loads for windlasses and crane rails of up to 31 N/mm^2 (317 kgf/cm^2) are acceptable.

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Maximum Design Bolt Load:	MBL = Design Static Load (DSL) N/mm^2 - Deadweight Load (DWL) N/mm^2 MBL = 4.41 N/mm^2 - 0.369 N/mm^2 MBL = 4.04 N/mm^2	N/mm^2	This is the portion of the Total Static Load that is born by the bolts.
Total Design Bolt Tension:	TBT = Bolt Load (MBL) N/mm^2 x Effective Chock Area (ECA) mm^2 TBT = 4.04 N/mm^2 x 385,525 mm^2 TBT = 1,557,821 N 2.5 x DWT = 355,980 N	N **TBT is Greater Than 2.5 x DWT**	TBT must be at least 2.5 x the Deadweight load of the equipment. If it is not, 2.5 x DWT will be used as the Total Bolt Tension in the following formula.
Design Tension Per Bolt:	BTE Total Bolt Tension (TBT) / Total Number of Bolts (TBN) BTE = 1,557,821 N / 14 Bolts BTE = 111,273 N/Bolt	N (max)/Bolt	
Actual Bolt Torque:	ABTQ = Bolt Tension (BTE) N x 0.2 x Thread Diameter (d) mm /1000 Bolt Torque is then rounded up as shown below.	Nm	See table below for results.
Actual Bolt Tension:	Actual Bolt Torque and the bolt's Pitch Diameter is used to calculate Bolt Tension with the following formula. ABTE = Bolt Torque (Nm) / (.0002 x Bolt Pitch Dia (Dp))	N	See table below for results.
Actual Bolt Stress:	ABS = Bolt Tension (N) / (Minor Dia - Dm^2 mm x 3.1415 / 4)	N/mm^2	See table below for results.

Actual Bolt Torque, Tension & Stress

	Quan	Bolt Size	ABTQ Actual Bolt Torque (N.m)	ABTE Actual Bolt Tension (N)	ABS Actual Bolt Stress (N/mm^2)	Yield Strength of Bolt (N/mm^2)	% of Yield
1	2	M20	**410**	111,557	456	660	69%
2	12	M20	**410**	111,557	456	660	69%
3	0						
4	0						
5	0						
6	0						
7	0						
8	0						

Comments

Actual Bolt Stress should not be greater than 70% to 90% of the bolts Yield Strength. Torque the clearance and fitted bolts to the torque recommended in the column titled "ABTQ Actual Bolt Torque N.m.

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		Quan	Bolt Size	Minimum Bolt Tension (N)	Maximum Bolt Tension (N)	Minimum Bolt Torque (N.m)	Breaking Torque (N.m)	% of Breaking Torque	Comments
Minimum Bolt Torque & Tension Plus Maximum Bolt Stress	1	2	M20	15,396	149,275	91	549	75%	Compare the Minimum and Maximum Bolt Tensions on the left to the Actual Bolt Tension above. The actual should be between the Minimum and Maximum tension. Also compare the Minimum and Breaking Torque for the bolts to the left with the Actual Bolt Torque above. The Actual Bolt Torque should be in between these numbers.
	2	12	M20	15,396	149,275	91	549	75%	
	3	0							
	4	0							
	5	0							
	6	0							
	7	0							
	8	0							

Total Actual Load:

TAL = DWL+[Working Load+(Tension per Bolt BTE x Number of Bolts)/Chock Area] N/mm^2

Estimated Working Load = - Newtons

TAL = 0.369 N/mm^2 + [(- + 1,557,821 Newtons) / 385,525

TAL = **4.41** N/mm^2

Comments: **The following applies only to winches and cranes.** Enter the Maximum Working Load that will be placed on the equipment. On continuously loaded equipment, the Total Actual Static Load (TAL) must be no more than 8.27 N/mm^2 (84.5 kgf/cm^2) for CF Orange and 5.52 N/mm^2 (56.3 kgf/cm^2) for CF Gray. On intermittently loaded equipment the Total Actual Static Load (TAL) must be no more than 24.5 N/mm2 (250 kgf/cm2) for CF Orange and 20 N/mm2 (204 kgf/cm2) for CF Gray. On equipment only seeing shock loads , the Total Actual Static Load (TAL) must be no more than 69 N/mm2 (703 kgf/cm2) for CF Orange and 40 N/mm2 (400 kgf/cm2) for CF Gray.

Notes:

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Material Required:	PRC Part No.	Description	Unit Size	Est Number of Units Required per Engine	Notes
	Maximum Thickness of Chocks:		**30 mm**		Chocks should be in the range of 12 mm to 70 mm
Chockfast Orange:	1010U	Unit of Chockfast Orange PR 610 TCF	3.4 kg (7.5 lb)	7	Estimate based on maximum thickness and 15% wastage.
	1020U	Unit of Chockfast Orange PR 610 TCF	6.8 kg (15 lb)	3	
Chockfast Grey:	1030U	Unit of Chockfast Gray PR 610 FR	5 kg (11 lb)		Estimate based on maximum thickness and 15% wastage.
	1050U	Unit of Chockfast Gray PR 610 FR	21.8 kg (48 lb)		
Damming Material:	7013	Open Cell Foam Strips	6'L x1" W x 1-3/4"T	10	180 cm L x 2.54 cm W x 4.45 cm T
	7016	Open Cell Foam Strips	6'L x 1"W x 2-3/4"T		180 cm L x 2.54 cm W x 6.99 cm T
Strip Caulk:	7003	Strip Caulking	60 ft per box	3	Calculation is based on the assumption that caulk will be used along the outboard edge of each chock.
Release Agent:	7068	PR-222 Mold Release Agent	16 oz. Can	1	
Non-Melt Grease:	7062	Non-Melt Grease	14.5 oz tube	1	Amount will vary based on number and size of bolts.
Mixing Blades:	7050	Jiffy Mixing Blade	Small HS	1	A mixing blade is required for each person mixing Chockfast.
	7051	Jiffy Mixing Blade	Medium ES		
	7053	Jiffy Mixing Blade	Large PS		
Surface Thermometer:	7017	Surface Thermometer in ^{o}F	1 ea	1	A thermometer is required to check the temperature of the chocking materials and the mounting pads either in ^{o}F or ^{o}C.
	7018	Surface Thermometer in ^{o}C			
Solvent:	7087	PRT-59 Solvent	1 Gal	1	Suggested for cleanup

Additional Materials:

Protective gloves	Screw drive or can opener	Heavy duty electric drill with an
Knife	Eye protection	operating speed of 200 RPM

Shipyard / Company:	
Vessel / Facility:	CCGS Samual Risley
Classed By:	Transport Canada
Location:	0
Machinery Type:	Main Engine
Make & Model:	Warsila VASA 12V
Total Deadweight:	14,515 kg DWT Including water, oil, fuel and accessories.
Prepared For:	Alan McKechnie
Company:	Altec
Prepared By:	Jim Kuly
Date Prepared:	10/13/2006

Clearance Bolt Stretch Calculations

	Length (mm)	Diameter (mm)
1	26	42
2	210	33
3	52	42
4		
5		

Measure the diameter of the shank on a clearance bolt and the length of the shank (not including the threads). If the shank has several different diameters, enter each diameter and the length of each section.

Modulus of Elasticity of the Bolt Material (E) = 207,000 N/mm^2

$$\text{Stretch (S)} = \frac{4 \times \text{Actual Bolt Tension - N (ABTE)}}{\text{Pi} \times \text{E}} \times (L1 / D1^2 + L2 / D2^2 \ldots L5 / D5^2)$$

$$\text{Stretch (S)} = \frac{4 \times 111{,}557 \text{ N}}{3.14 \times 207{,}000 \ N/mm^2} \times 0.2553 \text{ mm}$$

Stretch (S) = **0.1753** mm

Germanisher Lloyd's requires the Stretch (S) to be greater than 0.12 mm for chocks with loading < 3.5 N/mm2. For chocks >= 3.5 N/mm2, S >= **0.1513**

Fitted Bolt Stretch Calculations

	Length (mm)	Diameter (mm)
1	49	42
2	221	33
3	200	47.2
4		
5		

Measure the diameter of the shank on a fitted bolt and the length of the shank (not including the threads). If the shank has several different diameters, enter each diameter and the length of each section.

Modulus of Elasticity of the Bolt Material (E) = 207,000 N/mm^2

$$\text{Stretch (S)} = \frac{4 \times \text{Actual Bolt Tension - N (ABTE)}}{\text{Pi} \times \text{E}} \times (L1 / D1^2 + L2 / D2^2 \ldots L5 / D5^2)$$

$$\text{Stretch (S)} = \frac{4 \times 111{,}557 \text{ N}}{3.14 \times 207{,}000 \ N/mm^2} \times 0.3205 \text{ mm}$$

Stretch (S) = **0.2200** mm

Germanisher Lloyd's requires the Stretch (S) to be greater than 0.12 mm for chocks with loading < 3.5 N/mm2. For chocks >= 3.5 N/mm2, S >= **0.1513**