

S.S. "MODLIN" ex "WILJA"

Please see Manchester Reports N° 10607-08-09.

MAIN BOILERS.

2 Single ended, cylindrical, multitubular boilers built by Ateliers de Reparations Maritimes Beliard Crighton & Co., Havre, in 1926.

Plans of these boilers are not available and there is no information concerning the materials used in their construction, but it is stated that the vessel was classed with the Bureau Veritas at the time these replace boilers were constructed and installed.

The boilers have been measured and the following calculations are based on the assumption that the materials are in accordance with the requirements of the Rules.

PARTICULARS

W.P.	14 kg per sq cm	is	200 lbs per sq inch
Internal diameter	13' 7 1/2"		
Length	11' 8 1/2"		
Number of furnaces per boiler	3		
Heating surface per boiler	2100 sq. ft.		
Grate area per boiler	67.5 sq. ft.		

SHELL

Thickness 1 5/16" Diam. 163.5"

Long. joint triple riveted double butt strap

Rivets 1 7/16" diam. Pitch 9.06"

$$\text{Plate } \% = \frac{100(9.06 - 1.31)}{9.06} = 85.5 \%$$

$$\text{Rivet } \% = \frac{100(23 \times 1.35 \times 5 \times 1.875)}{28 \times 9.06 \times 1.31} = 87.6 \%$$

$$\text{Combined } \% = \frac{100(9.06 - 2.62)}{9.06} + 17.52 = 88.6 \%$$

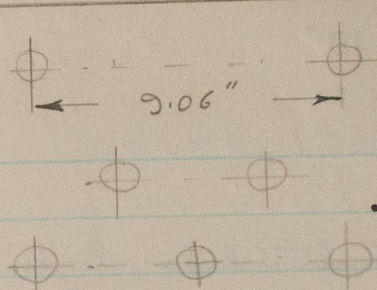
$$\text{W.P.} = \frac{(42 - 2) \times 28 \times 85.5}{2.75 \times 163.5} = 213 \text{ lbs}^2$$

$$\text{Outer butt strap } t = \frac{5 \times 7.75}{8 \times 6.44} \times 1.31 = 0.985" \text{ made } 1.06"$$

$$\text{Inner butt strap } t = 0.985 + 0.125 = 1.11" \text{ " } 1.18"$$

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RIVETING.



$$1.5 \times 1.31 = 1.965"$$

$$2 \times 9.06 + 1.5 \times 1.31 = 3.318"$$

$$.165 \times 9.06 + .67 \times 1.31 = 2.473"$$

$$1.5 \times 1.31 = 1.965"$$

$$\text{Total } 9.721" \quad \text{made } 9.37$$

$$\text{Maximum pitch } 6 \times 1.31 + 1.625 = 9.485"$$

Circumferential End Seams - Double Riveted Lap Joints

Diameter of rivets $1\frac{5}{16}"$ Pitch of rivets $3.75"$

$$\text{Plate } \# = \frac{100(3.75 - 1.31)}{3.75} = 64.12$$

$$\text{Rivet } \# = \frac{100(23 \times 1.35 \times 2)}{28 \times 3.75 \times 1.31} = 45.32$$

$$\text{Lower back end plate } \frac{7}{8}" \text{ thick } \# = 64.1 \times \frac{.875 \times 26}{1.31 \times 28} = 39.82 \text{ plus rivets}$$

FURNACES.

3" morning $1\frac{1}{16}"$ thick. Diam. $41"$

$$\text{W.P.} = \frac{480(22-1)}{41} = 246 \text{ lbs}^2$$

C.C. BOTTOM PLATE

$$\text{W.P.} = \frac{1450(24-1)^2}{(30.5 + 24) \times 46} = 306 \text{ lbs}^2$$

$$\text{W.P.} = \frac{50}{46} \times [10(24-1) - 30.5] = 217 \text{ lbs}^2$$

TOP END PLATES $1.18"$ thick ($\frac{37.8}{32}$) Steam space stays fitted with nuts inside & outside and loose washers.

Stays $3\frac{3}{16}"$ diam. rivelled to $3\frac{7}{16}"$ diam.

External washers $12" \phi \times \frac{7}{8}"$ thick. Internal washers $8\frac{3}{8}" \phi \times \frac{7}{8}"$ thick.

$$C = 100 \times \frac{(37.8-1)^2 + 0.15(28)^2}{(37.8-1)^2} = 108.6$$

$$\text{Pitch of stays (largest space)} \quad 15\frac{1}{2}" \times 18\frac{1}{2}"$$

$$\text{W.P.} = \frac{108.6(37.8-1)^2}{(15.5)^2 + (18.5)^2} = 254 \text{ lbs}^2$$

$$\text{Between tubes and stays above wide water space (2 stay tubes over back plate at bottom 2 steam space stays) W.P.} = \frac{80.3(37.8-1)^2}{(15.5)^2 + (16.25)^2} = 215 \text{ lbs}^2$$

At wing. Flanging, stay & stay tube. Largest circle $18" \phi$

$$\text{W.P.} = \frac{90.2(37.8-1)^2}{(18)^2} = 376 \text{ lbs}^2$$

Front tube plate. Wide water space.

Riveted strip $9\frac{3}{8}" \times \frac{25}{32}"$ Tube plate $1\frac{5}{16}"$ thick.

$$C = \frac{52[(30.0-1)^2 + 0.55(25)^2]}{(30.0-1)^2} = 73.3$$

$$\text{W.P.} = \frac{73.3(30.0-1)^2}{(14)^2 + (8.5)^2} = 229 \text{ lbs}^2$$

Back tube plate in nests

Pitch of stay tubes $8\frac{1}{2}" \times 8\frac{1}{2}"$

$$\text{W.P.} = \frac{38(30-1)^2}{(8.5)^2} = 442 \text{ lbs}^2$$

Back tube plate at wing

Stay 84, Stay tube 52, line of rivets 96 $\therefore C = 77.3$

$$\text{W.P.} = \frac{77.3(30.0-1)^2}{(12)^2} = 450 \text{ lbs}^2$$

Back tube plate in compression

Plain tubes $76/68$ mm ϕ $3" \text{ OD} \times 8 \text{ LSG}$.

Internal diam at end $2.68"$

$$\text{W.P.} = 875 \times \frac{(4.25-2.68) \times 30}{35 \times 4.25} = 277 \text{ lbs}^2$$

C. Girders. 3 Stays per girder at $8"$ pitch. Girders composed of two plates each $\frac{7}{8}"$ thick by $9\frac{3}{4}"$ deep. Pitch of girders $9\frac{3}{8}"$ back tube plate to c.c. back plate $2'11"$

$$= 175 \times 495 = 371$$

$$\text{W.P.} = \frac{371 \times (9.75)^2 \times 56}{(35-8) \times 9.375 \times 35} = 223 \text{ lbs}^2$$

$$\text{C. Back plate W.P.} = \frac{75(24-1)^2}{(8.375)^2 + (9)^2} = 262 \text{ lbs}^2$$

$$\text{Top plate W.P.} = \frac{75(24-1)^2}{(8)^2 + (9.375)^2} = 261 \text{ lbs}^2$$

$$\text{Side plate W.P.} = \frac{75(24-1)^2}{(7.875)^2 + (8.25)^2} = 305 \text{ lbs}^2$$

Back end plate at wide water space $t = \frac{7}{8}"$

$$\text{Pitch of stays } 14\frac{1}{2}" \times 9"$$

$$\text{W.P.} = \frac{86(28-1)^2}{(14.5)^2 + (9)^2} = 215 \text{ lbs}^2$$

Back plate at bottom

Riveted doubler $\frac{7}{8}"$ thick.

$$100 \left[\frac{(28-1)^2 + .85(28)^2}{(28-1)^2} \right] = 194$$

$$\text{at circle is } 26" \text{ diam through 3 stay}$$

$$\text{W.P.} = \frac{194(28-1)^2}{(26)^2} = 208 \text{ lbs}^2$$

W.P.

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MAIN STAYS

Stays $3\frac{7}{16}$ " diam. over thread. Area supported $17\frac{1}{2} \times 15\frac{1}{2}$ "
 W.P. = $\frac{(3.312 - .34)^2 \times 9500}{17.5 \times 15.5} = 309 \text{ lbs}^2$

Stays $3\frac{3}{16}$ " in body. Allowing stress of $11,000 \text{ lbs}^2$ W.P. = 322

Space between stays and stay tubes, above W.W. space.

Stand down of stays = $\frac{15.5 \times 309}{2 \times 200} = 11.96$ "

Sectional area of marginal stay tubes = 1.98^2

Area supported at W.P. = 200 is $\frac{1.98 \times 7500}{200} = 74.2$ "

Stand up of stay tubes $\frac{74.2}{1.125} = 66$ "

$11.96 + 6 = 17.96$ Stays to stay tubes measures $15\frac{3}{8}$ "

Stay tubes in nest Sectional area = 1.5^2
 Area supported = $8.5 \times 8.5 = 4 \times \frac{7}{4} (3)^2 = 43.9^2$
 W.P. = $\frac{1.5 \times 7500}{43.9} = 256 \text{ lbs}^2$

Screwed Stays

C.C. Stays $1\frac{3}{16}$ " diam. over threads 9 threads per inch
 Pitch $8" \times 9\frac{3}{8}"$ W.P. = $\frac{(1.813 - .267)^2 \times 8250}{8 \times 9.375} = 262$

Margin stays at W.W. space

$1\frac{7}{8}"$ diam. 9 threads per inch.

Area supported = $9 \times (4\frac{3}{16} + 7\frac{1}{4}) = 102.8^2$

W.P. = $\frac{(1.875 - .267)^2 \times 8250}{102.8} = 207 \text{ lbs}^2$

Plain tubes. External diam. 3"

For W.P. = 200 lbs^2 thickness reqd. is 8 LSG as fitted

Manhole compensation plate

Least percentage reqd. = 80.32

Section of shell cut out = $.803 \times 21 \times 1.31 = 22.1$

Compensation fitted = $1.312 \times 17.5 = 22.9$

Riveting = $25 \times \frac{7}{4} (1.31)^2 \times \frac{23}{28} = 27.7$

W.P. = 307

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ATING SURFACE.

Area $\pi \times 0.25 \times 8.55 (2 \times 85 + 84) = 1700 \text{ sq ft}$

Area $\pi \times 1.86 \times 8.55 \times 3 = 150$

Wrapper plates $14.3 \times 2.9 \times 2 + 21.7 \times 2.9 = 145$

C. Back plates = 60

Tube plates = 52

Total 2107 " Say 2100 sq ft.

FETY VALVES.

Area required for ordinary type = $\frac{2100 \times 6}{215 \times 4.8} = 12.2^2$

Minimum area reqd. for safety valves of an approved high lift type is 6.1^2 . Double, spring loaded valves of a high lift type, of unknown make, are fitted. Diameter = 60 mm

Area = $\frac{7}{4} (2.36)^2 \times 2 = 8.8^2$

accumulation test was carried out on the 16-6-41

with satisfactory results.

NKEY BOILER.

This boiler is stamped:-

Cochran & Co., Amman Ltd., Amman

Boiler No 7902 - 1919.

Maximum W.P. 150 lbs^2

The boiler also bears the stamp of a Surveyor to the Marine Veritas for hydraulic test, and the Firm's customary identification plate.

Since it is understood that Cochran's submit approval plans of all their standard boilers it is not considered necessary to measure the manholes on this boiler for the calculation of W.P. The Polish Steamship Company has been requested to obtain a plan from Cochran's IN ENGINES.

HP cylinder diameter 524 mm is 20.63 "

IP " " 885 " 34.84 "

LP " " 1550 " 61.02 "

Stroke 1000 " 39.37 "

The boilers are fitted with forced draught

W.P. = $\frac{200 + 590}{1500} \left[\frac{(61.02)^2 \times \sqrt{39.37}}{100} + \frac{4200}{12} \right] = 307 \text{ W.P.}$

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Diameter of intermediate shafting.

$$\sqrt[3]{\frac{(61.02)^2 \times 39.37 \times 200}{2150 \left[\left(\frac{61.02}{20.63} \right)^2 + 2 \right]}} = 10.82''$$

Crank & Thrust shafts $1.05 \times 10.82 = 11.35''$

Crank webs $h = 0.625 \times 11.35 = 7.09''$

IP & LP cranks $t = \sqrt{\frac{.12 \times (11.35)^3}{7.625}} = 4.80''$

H.P. cranks $t = \sqrt{\frac{.12 \times (11.35)^3}{7.125}} = 4.96''$

The after web of the HP crank is secured to take the coupling of the IP crankshaft. The total axial thickness is $7\frac{1}{8}''$. The radial thickness of metal around the eye-holes, as made, is considered satisfactory in view of the position in the engine.

Screw shaft.

Diam. of propeller $4840 \text{ mm} = 15' 10''$

Diam screw shaft $10.82 + \frac{190}{144} = 12.14''$

Bronze liner $t = \frac{12.14 + 9.25}{32} = 0.67''$

Coupling bolts $\sqrt{\frac{(10.82)^3}{3.5 \times 6 \times 8.75}} = 2.63''$

MAIN STEAM PIPES.

S.D. Copper $4\frac{1}{2}''$ internal diam. $\times 0.232''$ thick

W.P. = $\frac{(23.2 - 3) \times 60}{4.5} = 269 \text{ lbs}''$

BILGE PUMPING ARRANGEMENTS.

$L = 342.19'$

$B = 48.81$

$D = 27.71$

Main bilge line $\sqrt{\frac{342.19 (48.81 + 27.71)}{2500}} + 1 = 4\frac{1}{4}''$

SPACE C $\sqrt{\frac{129 \times 76.52}{1500}} + 1 = 3\frac{1}{2}''$

No 1 & 2 holds 129' $\sqrt{\frac{80 \times 76.52}{1500}} + 1 = 3''$

E & B.R. 80' $\sqrt{\frac{56 \times 76.52}{1500}} + 1 = 2\frac{3}{4}''$

No 3 hold 56' $\sqrt{\frac{65 \times 76.52}{1500}} + 1 = 2\frac{3}{4}''$

No 4 hold 65' $\sqrt{\frac{65 \times 76.52}{1500}} + 1 = 2\frac{3}{4}''$