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AND
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Branch Office,
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*16, Victoria Street,
Westminster,
London, S.W.1.*

Your ref.

Our ref. EFL/IEC.
L.N. 2470/3

7th August, 1924.

The Secretary,
Lloyd's Register of Shipping,
71, Fenchurch Street,
LONDON, E.C.3.

LLOYD'S REGISTER
Recd. 8 AUG. 1924
Ackd. 12 AUG 1924
Ans'd.
LONDON

Dear Sir,

NAUSICAA.

With reference to the case of the steamer Nausicaa and my report of the 29th May, I have made a careful examination of the pieces cut from the plating of this vessel and now beg to submit a further report.

Two pieces of plate were received for examination, each approximately $10\frac{1}{2}$ " x $5\frac{1}{2}$ " and stamped E8 NT and E8 T.A.R. respectively. The piece stamped E8 NT contained a rivet secured on the inside by nuts and a washer. In addition two pieces of new ship plate of the same thickness were received for comparison, one from Messrs. Dorman Long & Company, of Middlesbrough and the other from Messrs. David Colville & Company, of Glasgow.

All four pieces were drilled and analysed with the following results :-



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Laboratory Nos. ...	2470	2471	2472	2473
Marks	E8 NT	E8 TAR	Dorman Long & Co.	D. Colville & Sons
CARBON by combustion	0.168	0.140	0.158	0.191
SILICON	0.021	0.013	0.044	0.014
SULPHUR	0.069	0.049	0.030	0.069
PHOSPHORUS	0.036	0.028	0.014	0.035
MANGANESE	0.483	0.458	0.561	0.588

No exception can be taken to the composition of any of these plates, the analyses being typical of the average quality of ship plate being manufactured at the present time. The similarity between the analysis of E8 NT and Colville's plate is noticeable. The statement made by M. Guillet that the composition of the plates on the Nausicaa points to "insufficient deoxidation" is not borne out; but as M. Guillet had not sufficient of the material to carry out complete analyses it is unnecessary to discuss this point further. Several strips were cut from the plates in directions at right angles to one another and the whole section in every case polished and etched in order to detect the extent of segregation and lamination in each plate. The worst pieces were then cut out for more detailed examination under the microscope. In the course of this general examination various etching agents were employed (including the cupric chloride reagent advocated by M. Guillet) but no greater segregation or lamination than is commonly found in plates of this class could be detected.

There is, however, one feature of plate E8 Nt which has apparently not been mentioned by M. Guillet. Sections of this plate show that its surface has been distinctly decarbonised to a depth of $\frac{3}{22}$ of an inch, which is very much deeper than the surface decarbonisation which is normally found on plates. Such surface decarbonisation is not rare and can in most cases be attributed to the prolonged retention of an ingot in the soaking pit caused by some temporary breakdown or hitch at the mill. In

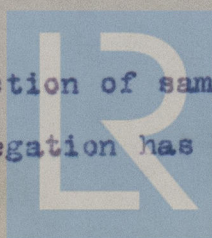
most cases it is not of great importance but in the present case it is of some interest as it is more than likely that a decarbonised plate if freely exposed to the action of corrosion would be more quickly attacked than a plate which had not been decarbonised. None of the ordinary tests carried out by the Inspector would reveal the presence of this decarbonised layer, and even if he were aware of its existence it is very doubtful if, in the present state of our knowledge on the subject, he would be justified in rejecting the plate.

Dealing now with the more detailed examination of the plates it may be said at once that the microscope failed to reveal any characteristics (other than the surface decarbonisation just described) which are not common to the ordinary run of ship plates. The accompanying photographs will serve better than any description to indicate the structure of the steel. In considering these photographs, however, it must be remembered that they represent the worst examples of segregation and lamination that could be found in the plates, and that (with one exception) they are taken at a magnification of 100 diameters, so that a slag inclusion measuring one inch in the photograph would in reality be only one hundredth of an inch long in the plate.

Photograph 1. shows a segregation of non-metallic matter (almost entirely manganese sulphide) in a polished but unetched section of E8 NT, while No. 2. shows a similarly treated section of the Colville plate. Neither of these are unusual and therefore call for no comment.

No. 3. shows the structure of E8 NT after etching. The laminated structure is noticeable and the manganese sulphide can be seen between the carbide laminations. No. 4. shows a section of the Colville plate etched in the same way and exhibiting the same type of lamination.

No. 5. shows an etched section of sample E8 T.A.R. in which a somewhat larger line of segregation has been located and



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No. 6. at 1000 diameters shows the characteristic pearlite structure of the carbide, together with an inclusion of manganese sulphide and some minute particles of oxide. Nos. 7 and 8 show the partially decarbonised layer near the surface of sample E3 NT and the normal structure near the centre respectively.

M. Guillet in his report attributes the corrosion of the plates to the fact that the steel from which they were rolled was oxidised, and he arrives at this conclusion as the result of certain etching tests with cupric chloride reagents as described by M. Le Chatelier in 1919. His conclusions are not confirmed by any actual determinations of oxygen or oxide; but as his assertions are made with considerable confidence and in view of the fact that oxidised steel is liable to more rapid corrosion than a deoxidised steel it may be advisable to consider the subject in some detail.

More than ten years ago I drew attention to the liability to corrosion of oxidised steel in papers before the Iron and Steel Institute and Institute of Metals and supported my conclusions by actual determinations of oxygen. Unfortunately these determinations are exceedingly laborious and the methods are only suitable for a research laboratory. In 1919 Le Chatelier and Bogitch made claims (unsupported by analysis) that oxide of iron being electro-positive to iron was unaffected in the presence of a cupric reagent while metallic copper was deposited on the remainder of the sample free from oxide. Thus the segregated portions containing oxide of iron remained white. Dr. Stead immediately took up the subject and in 1921 in a paper before the Iron and Steel Institute pointed out that phosphorus, nickel, copper, silicon and chromium when in solution in iron are also electro positive to iron and remain white on being attacked by a cupric reagent. He says that he "had repeatedly failed to reproduce their results by burning pure electro-iron on a magnesia lined base in oxygen in such a way that buttons of fused iron were obtained covered by thick layers of cinder. That the buttons were

highly charged with free oxide was evident when examined under the microscope, for it appeared in the form of minute black globules".

"On polishing and staining with all available cupric reagents the copper always deposited evenly over the surface, and on dovetailing into the specimen strips of the original electro-iron and polishing and copper staining the two surfaces again the copper deposited equally on each".

In the same year (1921) Mr. J. H. Whitely, after a lengthy research on the subject stated that "the presence of oxygen in uneven distribution has not been found to yield, with the cupric reagents, effects similar to those given by even the smallest variation of phosphorus."

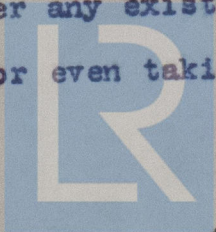
These opinions are now generally accepted in this country, and the use of a cupric reagent as proof of the existence of oxide in steel would certainly not be accepted.

Elaborate chemical analyses have shown that Open Hearth steel contains 0.005 to 0.045 per cent of oxygen, the average for Basic Open Hearth being about 0.02, but no one has yet suggested either the percentage which is undesirable or a practical method of determining it. Under the circumstances, therefore, the percentage of oxygen is outside the sphere of practical specifications.

As the result of my examination of these plates my conclusions are as follows:-

1. That a distinction must be drawn between practical and research methods of testing, and that, in the present state of our knowledge, Lloyds tests are entirely satisfactory and sufficient.

2. That the plates exhibit no features which would justify an Inspector, working under any existing specification that I am aware of, in rejecting or even taking exception to them.



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The Secretary.

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3. That the opinions expressed in my report of the 29th May are confirmed - viz. that the corrosion has been caused by the removal of paint, but that it has now been stopped, and provided the plates are painted there should be no further trouble due to corrosion.

Yours faithfully,

W. F. Law

ENCL.



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For the Chief Surveyors

A.S.

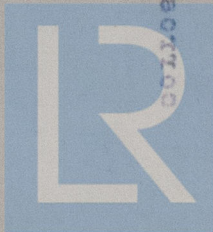
8/8/24

for Mr. Redman
to note
It is submitted copy of this report be
together with the accompanying photographs + for any
forwarded to Mr. Redman for his information + for any
comments he might desire to make on the same
P.R.
12.8.24

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