

OTTAWA June 30th, 1943.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1440.

Examination of Buckled and Distorted Boiler Tubing.

Bureau of Mines Division of Metallie Minerals Cre-Dressing and Matallur ical

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Origin of Samples:

On June 12, 1945, A/Lt. Cdr. J. R. Millard, Senior Technician, Technical Division, Department of National Defence, Naval Service, Ottawa, Ganada, submitted (letter of June 10th, File No. 29-55-1 FD 1114) samples of boiler tubing received from the Collingwood Shipyards Limited. The tubes, said to be made in the United Kingdom, were reported to be fire row tubes as fitted to a Yarrow's water tube boiler which buckled and distorted in steaming up.

It was stated that of the several possible causes of failure the presence of oil in the feed water heater, if not in the boiler proper, was the most probable. Among other possibilities listed was the use of oversize or defective material.

Object of Study:

It was requested that tube dimensions and physical properties be determined and that microstructure examination be carried out.

Chomical Analysis:

After grinding-off the surface layer of one of the tubes, material for chemical analysis was removed with a milling cutter. The results were:

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,	Por cont
-111	0,08
	0.45
	0,08
47×	0,040
57	0,016
	0.11
72	0.04
12,	None detected,
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Physical Examination;

Hardness tests (taken on a Vickers machine with A 10-kilogram load) on the tubes gave readings of 102 to 106 Vickers.

Since nominal dimensions of the tube were not given, tolerances as specified in Specification N466 could not be checked, but the following measurements were taken from least scaled portions of the tube;

> Thickness - 0.121 to 0.1245 inch, with mest readings 0.123 inch.

> Outside Diameter - 1.503 to 1.506 inch, with most readings 1.504 inch.

A tensile test on a straight length of tubing gave the following results:

Ultimate stress, p.s.i.	 48,700
Yield point, p.s.i.	 28, 900
por cent	 34.5

A ring from one of the pieces of tubing passed a flattening test.

Macrostructures:

Specimens were removed from the buckled and distorted parts of the tube and polished on faces parallel to the long axis of the tubing. The structure of the steel in one of these areas is given in Figure 1. The duplex grain network observed - Page 3 -

(Microstructures, cont'd) -

in the ferrite is generally considered to be a gamma network superimposed on the alpha grains. According to work of Rawdon and Berglund⁴ it has little or no effect on mechanical properties. This gamma network is not nearly so noticeable in other samples of tubing in the lot submitted. The particular specimen photographed has its carbide constituent present both as pearlite and as globules along the grain boundaries, while in others the visible carbide is present as pearlite. The steel in the tubing was found to be quite clean.

Figure 1.



X100, nital etch.

LONGITUDINAL SECTION FROM ONE OF THE BUCKLED AREAS.

Discussion of Results:

Chemical analysis results show that the steel is of the normal low carbon type. The nickel and chromium present are probably tramp elements.

Whether or not tube thickness tolerances have been violated may be readily checked from the figures given.

The tubing meets the required mechanical tests quite

H. S. Rawdon and T. Berglund - Unusual Features in the Microstructure of Ferrite, National Bur. Stds. Sci. Papers V. 22, 1927-1928, pp. 649-717. (Discussion of Results, cont'd) -

satisfactorily. No metallurgical defects were discovered. It would seem, therefore, that failure was caused by mechanical shortcomings in the installation or operation of the boilers rather than by metallurgical deficiencies in the tube itself.

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