OTTAWA July 9th, 1941.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1046.

Examination of Fractured Fire-Hose Coupling.

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA

DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Origin of Request:

Analysis Requisition No. J.M.G. 987, issued by the Inspection Board of the United Kingdom and Canada, Ottawa, Ontario, on June 19th, 1941, was referred to the Metallurgical Laboratories of the Bureau of Mines by Mr. Archibald of the National Research Council. It was requested that the cause of failure of the fire-hose coupling submitted be investigated. The coupling was received at the Bureau of Mines on June 25th, 1941.

Description of Coupling:

The 3-inch coupling is shown in Figure 1 after drillings for analysis had been taken. A close-up of the fracture is shown in Figure 2.

Figure 1.

Fire-Hose Coupling as received.

Figure 2.

Fracture in Coupling.

Chemical Analysis:

		Per cent
Copper	-	85.62
Zinc	-	4.74
Lead	-	3.67
Tin	-	5.27
Phosphorus	-	0.04
Iron	-	0.18
Nickel	-	0.29

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Microstructure:

Figure 3.

X 100, unetched.
Edge of Fracture.

Figure 4.

X 100, unetched.
Near Fracture.

Figure 5.

X 100, etched with
aqueous solution of
NH_4OH and H_2O_2.

TYPICAL CORED STRUCTURE.

Figures 3 and 5 show the lead (black) distributed in the copper. Figure 5 shows the grain size as outlined by segregation on cooling. Distribution of the lead is irregular, and the fracture apparently passed through large lead spots.

Hardness Test:

59 V. H. N.

Micro X-Ray:

Micro X-ray photographs taken by L. W. Ball (on loan from the National Research Council) showed that the metal itself was sound but that lead had separated out in large irregular formations.

Figure 6.

Micro X-Ray, 100 diameters.

DISCUSSION OF RESULTS:

The metal in the coupling examined is the well known and widely used 85-5-5-5 (copper-tin-zinc-lead) copper alloy covered by A.S.T.M. Designation B 62-36. Due to the ease with which sound castings can be made from this metal, it is used extensively for low pressure water and steam fittings. Physical properties of this alloy are dependent upon several variables such as melting practice, pouring temperature, deoxidation practice, chemical analysis, etc.

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(Discussion of Results, cont'd) -

In this case manufacturing practice has resulted in segregation of the lead in such a way as to weaken the metal. For ordinary applications this metal would be entirely satisfactory; however, it is apparent that this fire-hose coupling has not had sufficient strength to sustain the stresses applied in service and for testing.

Effect of Lead:

Several advantages accrue from the presence of lead in a copper-tin-zinc alloy. Lead improves the soundness of the casting and therefore makes founding easier. Machineability is improved when lead is added in amounts up to 2 per cent. Lead-bearing brass and bronze has a self-lubricating property that makes it stand up well under friction. As lead increases beyond 2 per cent there is a reduction in tensile strength, impact strength, and elongation; therefore, in lead-bearing brass and bronze it is of vital importance to obtain a uniform distribution of lead globules, so that physical properties will be as high as possible.

Prevention of Lead Segregation:

Tin is used regularly in copper-lead alloys to prevent the segregation of lead. Nickel is also used for this purpose.

Pouring temperature and rate of cooling in the mould influence lead distribution and therefore should be closely controlled.

Sulphur, antimony, phosphorus, manganese, silicon, calcium, barium, zirconium, and sodium, have been added during melting of copper-lead alloys in order to effect better dispersion of the lead.

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(Prevention of Lead Segregation, cont'd) -

It is claimed that by the use of a satisfactory flux, segregation of lead may be prevented. Flux materials used are:

		Type.
Borax Salt Sulphur	-	No. 1.
Soda ash Plaster of paris Salt	-	No. 2.
Barium sulphate	-	No. 3.
Calcium carbide Calcined borax	-	No. 4.

Since this fire-hose coupling has marked segregation of lead, it is obvious that the manufacturers have not paid sufficient attention to the above and other factors.

Conclusions:

1. Assuming that normal service stresses were applied in fracturing the fire-hose coupling, it is then apparent that the metal failed due to lead segregation.

2. The metal in the coupling is Ounce Metal, commonly called 85-5-5-5 (copper-zinc-tin-lead). This metal is used extensively for low-pressure water and steam fittings.

3. A much better distribution of lead could be obtained if greater care were exercised in the manufacture of this metal.

4. The addition of nickel up to 2 per cent would make a stronger metal.

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APPENDIX.

Comparison of Properties of Some Copper-Base Alloys.

A.S.T.M. Specification No.	Cu	Sn	Mn	Zn	Al	Pb	Ni	Fe	Elongation in 2 inches, per cent	Ultimate strength, p.s.i.
	PERCENTAGES									
B62-36	85	5		5		5			20	30,000
B60-36	88	8		4					22	38,000
B61-36	86	6		3		2	1		21	34,000
B54-39	58	1	3	35	1	0.2		1	25	65,000
B59-39	86				9			3	20	65,000

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