LEAD INDUSTRIES ASSOCIATION

420 ~~LEXINGTON AVENUE~~ 60 East 42nd Street

NEW YORK 17, N. Y.

December 18, 1956

SUBJECT: LEAD IN STEEL

To Members of the Lead Industries Association:

Although it is far from a major use of lead, there is definitely an increasing interest in steels containing small percentages of lead, both for free machining steels and more recently for forgings. For that reason we believe that you may be interested in the attached reprint of an article from STEEL magazine, October 29, 1956, comparing some of the properties of leaded and non-leaded steels.

We have a limited supply of additional copies and will be glad to take care of requests for them as long as they are available.

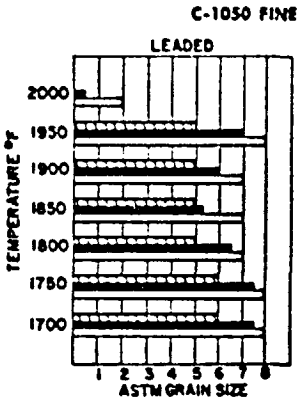
Very truly yours,

Secretary-Treasurer.

Leaded Vs. Nonleaded Steel

(C-1050 and C-1141)

1. Brinell hardness:	No significant difference
2. Yield and tensile strength:	No significant difference
3. Grain size:	A little smaller in leaded steel
4. Charpy impact:	Transition temperatures average 22°F lower



Austenitic grains in leaded and nonleaded steels. White bars are mini-

How Much Does Lead Change Steel?

It does much to improve metallurgical properties, says Inland Steel. Here are results of tests on C-1050 and C-1141 steels. Impact transition temperatures average 22°F lower

METALLURGISTS have debated several questions since leaded steels were introduced, including: Does lead hurt tensile and yield strength? What about brittle fracture?

To get some answers, Inland Steel Co., East Chicago, Ind., tested three heats of C-1050 and C-1141 steels, leaded and nonleaded.

A. P. Weaver, Inland's senior metallurgist, gave ASM members the results week before last at their convention in Cleveland. Summarized above, they point up the fact that lead's benefits aren't restricted to machinability.

Scope—To reduce the variation in the tests, two consecutive ingots were taken from the middle portion of selected heats. Lead was added to one.

The ingots were rolled into rounds. All lots were normalized at 1650°F, quenched in oil at 1550°F, and drawn for 2 hours at 100°F to check their impact resistance at higher hardnesses.

Impact—In the Charpy V-notch tests, most of the leaded samples showed lower transition temperatures than nonleaded ones of the same grade and composition. Below the transition temperatures, leaded steels had higher impact energies than nonleaded ones; above, they had lower impact values.

In all cases, normalizing increased resistance to impact. A quench and a draw gave still higher impact and lower transition temperatures.

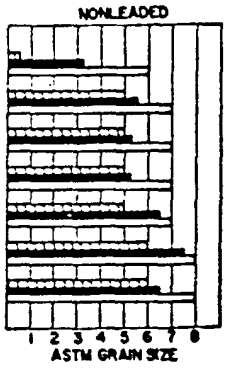
Results—Generally, you can draw these conclusions from Inland's tests: 1. Lead lowers the Charpy transition temperatures. (It's probably due to the moderate grain refinement.) 2. Heat treatment lowers the transition temperatures on coarse-grained C-1050 steel—15°F in hot rolling, 30°F after normalizing and 50°F after quenching and drawing. 3. Lead refines coarse grained C-1050 steel. It has less effect on fine grained material.

Greater Spread—At the lowest temperatures, the fractures of all samples were brittle. On all but the normalized, quenched and drawn, coarse grain series, the fractures remained brittle up to about the transition temperatures. The fractures became less brittle and more ductile while going through the transition range until at higher temperatures the fractures were completely ductile.

Brittle fracture disappeared completely at lower temperatures on the normalized series of both the coarse and fine grained C-1050 steels than on either the straight hot rolled or the quenched and drawn series. Fracture curves generally agreed with the impact energy curves.

Keyhole — A series of Charpy Keyhole (impact) tests was made on the C-1141 lots. In each of the four conditions (hot rolled, cold

GRAIN PRACTICE



mum; black show the predominant and cross-hatched ones the maximum

How much does lead change steel?

Sample	Hot Rolled	Normalized	Quenched & Drawn
C-1050 (Coarse Grain)			
Leaded	160°F	85°F	120°F
Nonleaded	175	115	170
C-1050 (Fine Grain)			
Leaded	110	45	30
Nonleaded	100	55	45
C-1141			
Leaded		30	
Nonleaded		55	
C-1141 (Charpy Keyhole)			
Leaded		−20	
Nonleaded		−10	

Charpy V-notch transition at 15 ft-lb energy level

drawn, quenched and drawn, and normalized), the leaded and nonleaded samples came successively nearer to having the same impact energies. Inland assumes that it resulted from hot mill finishing practice.

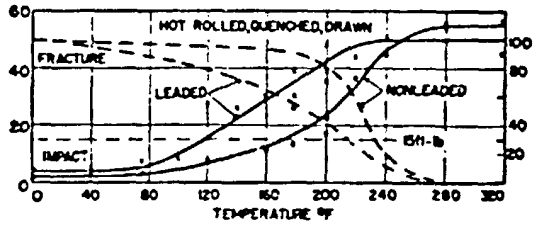
The 15 ft-lb energy level used for ship plate is too low for the normalized and for the quenched and drawn lots, Inland concluded.

Grain—Photomicrographs of the test samples support the fact that lead refines grain structure.

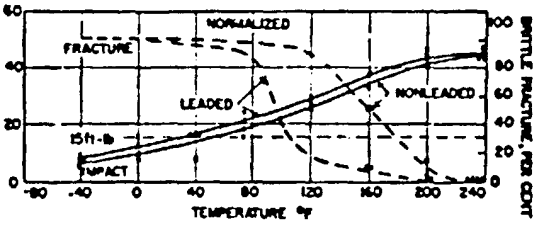
Inland's work also supports the findings of others on grain refinement and transition temperatures: They drop about 25°F per ferritic grain size number.

Observation — E. W. Husemann, chief metallurgist, Copperweld Steel Co., Warren, O., commented that much more research like this is needed on all grades of steel.

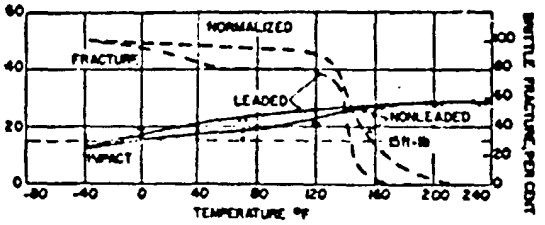
It is his opinion that research will show that leaded and nonleaded steels can be used interchangeably, and that the machining properties of any steel are improved by the addition of lead.



Charpy V-notch impact tests on coarse grained, C-1050 steel



Charpy V-notch impact tests on C-1141 steel, leaded and nonleaded



Charpy Keyhole impact tests on C-1141 steel, leaded and nonleaded