

Lincoln Electric Liquid Hydrogen Applications

Full 316NF Consumables Solution

The most complete range
of **Non-Ferrite** stainless
steel filler metals for
liquid hydrogen storage
applications



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LINCOLN[®]
ELECTRIC

Unlocking the Future of Hydrogen: Welded for Cryogenic Excellence

As the world accelerates toward decarbonization, **liquid hydrogen (LH2)** is emerging as a game-changer in clean energy. With its **superior volumetric energy density**, LH2 enables efficient large-scale transport and storage—imagine replacing 848 gas cylinders with a single cryogenic tank.

But tapping into LH2's potential demands more than just infrastructure—it also requires **materials and welds that perform flawlessly at 20 Kelvin**. Traditional stainless steels like **304L and 316L** offer excellent base metal toughness, but **weld integrity** is the real challenge.

The Challenge:

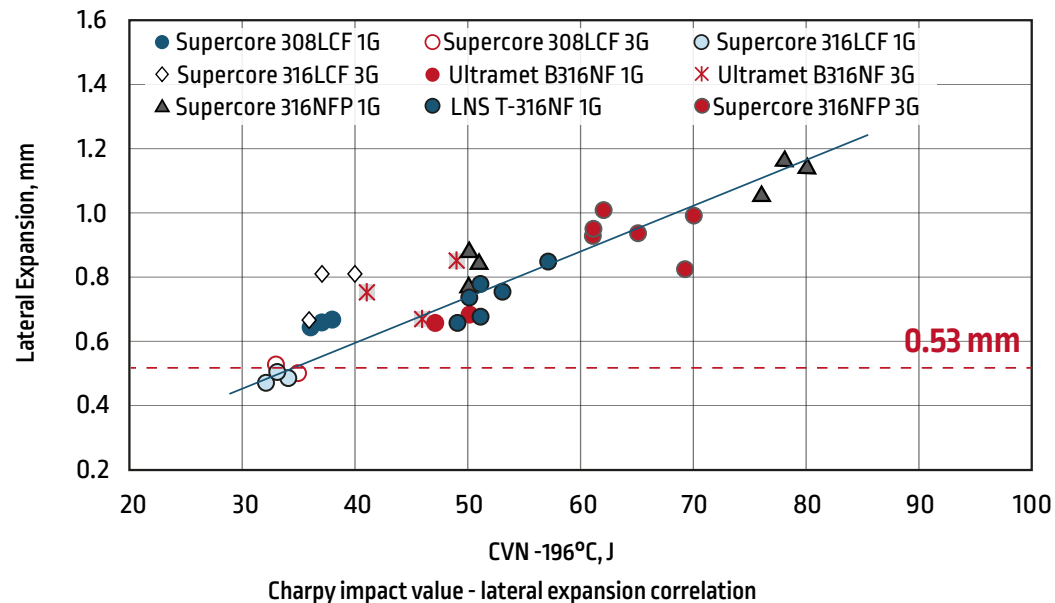
Standard, and even Low Controlled Ferrite (LCF) stainless steel filler metals always face challenges in consistently meeting the stringent toughness requirement of 0.53 mm minimum Charpy lateral expansion at -196°C, which is essential for qualifying welds for LH2 applications.

Our Breakthrough:

We engineered a new range of **Non-Ferrite (NF) stainless steel welding filler metals** specifically for LH2 applications—featuring an optimized alloy design that produces balanced weld microstructures, superior cryogenic toughness and excellent resistance to weld cracking.

The result?

Welds that **consistently meet the required 0.53 mm minimum Charpy lateral expansion at -196°C**, across all positions and processes



The NF package Lineup:



ER316MnNF
GTAW Rod

for high-integrity root passes



Ultramet B316NF
SMAW Electrode

for versatile manual welding



Supercore 316NFP
FCAW wire

for high productivity welding in all positions



LNS T-316NF
SAW Wire

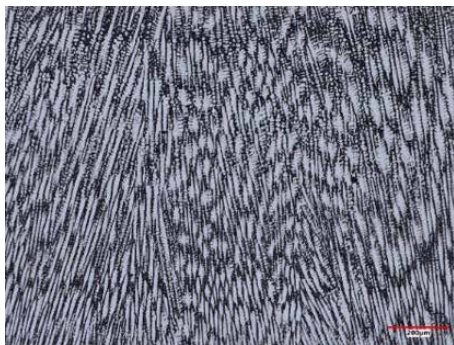
for highest productivity and automated fabrication



P2000
SAW Flux

Microstructure Features and Proven Performance:

- **Fully austenitic weld metal** with no ferrite, confirmed by both WRC-1992 prediction and measurement [*]
- **Complete product range and excellent welding operability** offer choices of processes and ideal suitability for fabrications across all positions.
- **Superior cryogenic toughness with adequate strength and ductility**—no trade-offs
- **Strong resistance to hot cracking** demonstrated in restrained joint tests, thanks to optimized designs of formula chemistry and adaptability to welding procedures

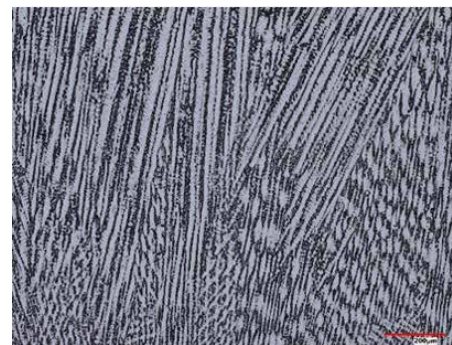


Mid-section

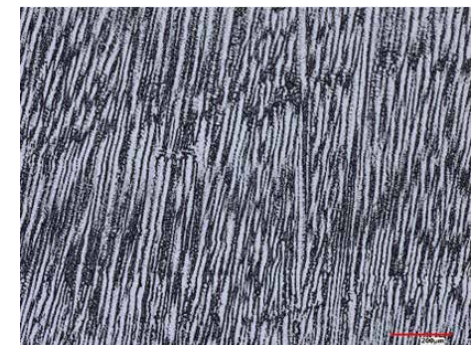


Cap-section

SMAW weld microstructure (Ultramet B316NF, welding position 1G)



Mid-section



Cap-section

FCAW weld microstructure (Supercore 316NFP, welding position 3G)

Lincoln Electric 316NF solution



RELIABLE AND SAFE

the NF design guarantees, with a large margin, the achievement of the most stringent requirements



PRODUCTIVITY

high thicknesses covered by high deposition processes (FCAW; SAW)



VERSATILE

all positions
(SMAW)



CUSTOMER ASSISTANCE POLICY

The business of The Lincoln Electric Company® is manufacturing and selling high quality welding equipment, consumables, and cutting equipment. Our challenge is to meet the needs of our customers and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for information or advice about their use of our products. Our employees respond to enquiries to the best of their ability based on information provided to them by the customers and the knowledge they may have concerning the application. Our employees, however, are not in a position to verify the information provided or to evaluate the engineering requirements for the particular weldment. Accordingly, Lincoln Electric does not warrant or guarantee or assume any liability with respect to such information or advice. Moreover, the provision of such information or advice does not create, expand, or alter any warranty on our products. Any express or implied warranty that might arise from the information or advice, including any implied warranty of merchantability or any warranty of fitness for any customers' particular purpose is specifically disclaimed.

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