LIFTHI

Q&T Structural Steel

LEONG JIN CORPORATION

SINCE 1971

ELITE PROVIDER OF STEEL

Founded in 1971, Leong Jin Corporation has matured from being a purveyor of steel to becoming a premier name within the global steel industry. We pioneered the expertise of acquiring a comprehensive range of special steel and strive for prompt, efficient deliveries. Leong Jin Corporation is now a specialist, a one-stop procurement centre, and a place for special steel solutions.

Widening our product offerings to include an extensive range of services like forging,state-of-art cutting and pre-machining, we believe in providing our customers convenience with a one-stop-shop solution. Together with our business partners and customers, we support a strong focus on quality control and safety at all times. Leong Jin Corporation has also achieved International Organization for Standardization (ISO) certifications, namely ISO 9001, ISO 14001 and OHSAS 18001. Materials Testing Center of Leong Jin has been accredited in accordance with ISO / IEC 17025.

WearTuf & LiftHi

WEARTUF Q&T Wear Steel

LIFTHI Q&T Structural Steel

As Leong Jin aims to be a global market player in the premium Q&T steel plates industry, we are launching for the first time in history, our very own brand of Q&T steel plates - namely WearTuf(Q&T wear resistance steel plates) and LiftHi (Q&T structural steel plates). This is the result of our relentless commitment to R&D (research & development) in pursuit of quality and durability in our products.

Our Q&T steel plates envisage to become customer's first choice and top-of-mind products within their application and market segments. Supporting our customers with greater value-added services and new innovative light weight designs, we take pride in assuring consistent, high quality premium Q&T products in our one stop service centre.

Product Datasheet

LiftHi 700

LiftHi 900

LiftHi 960

LiftHi 1100

LIFTHI
Q&T Structural Steel

LiftHi 700

Revision:03

CHARACTERISTICS

LiftHi 700 is a fully martensitic Q&T extra high strength structural steel. LiftHi 700 complies with S690QL, according to EN 10025-6, but offers closer overall tolerances, improved impact toughness and work shop performance. Due to the lean composition of LiftHi 700 the weldability stays extremely good along with cold forming capability.

APPLICATIONS

The applications segments in which LiftHi 700 are most frequently found is within truck chassis, outriggers, various lifting and handling equipment.

DIMENSIONS

LiftHi 700 is supplied in the thickness range of 4.0 - 50.0 mm and in plate width of 900 – 3 100 mm. Supplied plate length from 4 000 to 18 000 mm.

TENSILE PROPERTIES

Yield strength Rp0.2, min	Tensile strength Rm	Elongation A5, min
700 MPa	780-930 MPa	14%

Uniaxial tensile testing is performed in the transverse direction to rolling according to EN ISO 6892-1.

IMPACT TOUGHNESS

Min 70J/-40°C (-40 °F)

The impact toughness is given as absorbed energy at temperature being the average of three full size Charpy-V test samples in transverse direction to rolling, according to EN ISO 148-1 (*)

CHEMICAL COMPOSITION

Ladle analysis: The steel is grain refined and fully killed, wt%

Thickness (mm)	C max	Si max	Mn max	P max	S max	Cr max	Ni max	Mo max	B max	CEV Typical	CET Typical
4.0 – 25.0	0.16	0.60	1.50	0.025	0.010	0.50	0.10	0.40	0.004	0.42	0.28
25.1 – 50.0	0.18	0.60	1.50	0.025	0.010	0.60	0.10	0.60	0.004	0.48	0.32

$$CET = C + \frac{Mn + Mo}{10} + \frac{Cr + Cu}{20} + \frac{Ni}{40}$$

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

ULTRASONIC TESTING

All plates delivered meets the Class E1, S1 requirement, according to EN 10160.

DELIVERY CONDITION

LiftHi 700 is delivered as quenched and tempered (QT). (Q: according to EN 10025-6).
The plates are delivered with sheared or thermally cut edges.

TOLERANCES

The thickness tolerances of LiftHi 700 meets and exceeds the thickness tolerance of EN 10029 Class A (**). Tolerances on shape, length and width meet the requirements of EN 10029. Flatness tolerances conforms to EN 10029 Class S, or closer. For more information, consult the Leong Jin catalogue: General Product Information.

SURFACE CONDITION AND PROPERTIES

The delivered surface finish meets and exceeds that of EN 10163-2 Class A Subclass 3.

The plates will be delivered as painted, using a low zinc silicate corrosion protective shop primer. Plates can also be delivered as unpainted.

HEAT TREATMENT

LiftHi 700 is not designed for applications requiring working or service temperatures above 550°C. If exceeding this temperature, the mechanical properties of the steel can no longer be guaranteed.

PROCESSING PERFORMANCE

More information on the steel processing performance of LiftHi 700 can be found by consulting the LiftHi 700 Technical manuals on 1) Bending, 2) Welding, 3) Cutting and 4) Machining.

(*) According to EN 10025-1, In plate thickness less than 12 mm, subsize Charpy test samples are used. The specified min value is then proportional to the cross section of the sample. Impact tests are not required for nominal thickness < 6 mm.

(**) In the range of 4.0 – 12.0 mm the Leong Jin thickness tolerances can be offered.

LiftHi 900

Revision:01

CHARACTERISTICS

LiftHi 900 is a fully martensitic Q&T ultra high strength structural steel plate. LiftHi 900 complies with S890QL, according to EN 10025-6, but offers close overall tolerances and excellent work shop performance. LiftHi 900 provides a very good weldability and is well suited for cold forming operations.

APPLICATIONS

LiftHi 900 is commonly used in various types of lifting appliances, concrete pump truck boom sections, outriggers and heavy truck chassis.

DIMENSIONS

LiftHi 900 is supplied in the thickness range of 4.0 - 30.0 mm and in plate width of 900 – 3 100 mm and in plate length from 3 000 to 18 000 mm.

TENSILE PROPERTIES

Yield strength Rp0.2, min	Tensile strength Rm	Elongation A5, min
900 MPa	940-1100 MPa	12%

Uniaxial tensile testing is performed in the transverse direction to rolling according to EN ISO 6892-1.

IMPACT TOUGHNESS

Min 70J/-40°C (-40 °F)

The impact toughness is given as absorbed energy at temperature being the average of three full size Charpy-V test samples in transverse direction to rolling, according to EN ISO 148-1 (*)

CHEMICAL COMPOSITION

Ladle analysis: The steel is grain refined and fully killed, wt%

Thickness (mm)	C max	Si max	Mn max	P max	S max	Cr max	Ni max	Mo max	B max	CEV Typical	CET Typical
4.0 – 30.0	0.19	0.60	1.50	0.020	0.010	0.50	0.20	0.80	0.004	0.54	0.36

$$\text{CET} = C + \frac{Mn + Mo}{10} + \frac{Cr + Cu}{20} + \frac{Ni}{40} \qquad \text{CEV} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

ULTRASONIC TESTING

All plates delivered meets the Class E2, S2 requirement, according to EN 10160.

DELIVERY CONDITION

LiftHi 900 is delivered as quenched and tempered (QT). (Q: according to EN 10025-6).
The plates are delivered with sheared or thermally cut edges.

TOLERANCES

The thickness tolerances of LiftHi 900 meets and exceeds the thickness tolerance of EN 10029 Class A (**). Tolerances on shape, length and width meet the requirements of EN 10029. Flatness tolerances conforms to EN 10029 Class S, or closer. For more information, consult the Leong Jin catalogue: General Product Information.

SURFACE CONDITION AND PROPERTIES

The delivered surface finish meets and exceeds that of EN 10163-2 Class A Subclass 3.

The plates will be delivered as painted, using a low zinc silicate corrosion protective shop primer. Plates can also be delivered as unpainted.

HEAT TREATMENT

LiftHi 900 is not designed for applications requiring working or service temperatures above 550°C. If exceeding this temperature, the mechanical properties of the steel can no longer be guaranteed.

PROCESSING PERFORMANCE

More information on the steel processing performance of LiftHi 900 can be found by consulting the LiftHi 900 Technical manuals on 1) Bending, 2) Welding, 3) Cutting and 4)Machining.

(*) According to EN 10025-1, In plate thickness less than 12 mm, subsize Charpy test samples are used. The specified min value is then proportional to the cross section of the sample. Impact tests are not required for nominal thickness < 6 mm.

(**) In the range of 4.0 – 12.0 mm the Leong Jin thickness tolerances can be offered.

LiftHi 960

Revision:02

CHARACTERISTICS

LiftHi 960 is a fully martensitic Q&T ultra high strength structural steel plate. LiftHi 960 complies with S960QL, according to EN 10025-6, but offers improved toughness and work shop performance. LiftHi 960 provides a very good weldability and is well suited for cold forming operations.

APPLICATIONS

LiftHi 960 is mainly used in various types of lifting appliances such as mobile and truck crane boom sections and other types of outriggers.

DIMENSIONS

LiftHi 960 is supplied in the thickness range of 4.0 - 30.0 mm and in plate width of 900 – 3 100 mm and in plate length from 3 000 to 18 000 mm.

TENSILE PROPERTIES

Yield strength Rp0.2, min	Tensile strength Rm	Elongation A5, min
960 MPa	980-1150 MPa	12%

Uniaxial tensile testing is performed in the transverse direction to rolling according to EN ISO 6892-1.

IMPACT TOUGHNESS

Min 35J/-40 °C (-40 °F)

The impact toughness is given as absorbed energy at temperature being the average of three full size Charpy-V test samples in transverse direction to rolling, according to EN ISO 148-1 (*)

CHEMICAL COMPOSITION

Ladle analysis: The steel is grain refined and fully killed, wt%

Thickness (mm)	C max	Si max	Mn max	P max	S max	Cr max	Ni max	Mo max	B max	CEV Typical	CET Typical
4.0 – 30.0	0.19	0.80	1.50	0.020	0.010	0.60	0.40	0.80	0.004	0.54	0.36

$$\text{CET} = C + \frac{Mn + Mo}{10} + \frac{Cr + Cu}{20} + \frac{Ni}{40}$$

$$\text{CEV} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

ULTRASONIC TESTING

All plates delivered meets the Class E2, S2 requirement, according to EN 10160.

DELIVERY CONDITION

LiftHi 960 is delivered as quenched and tempered (QT). (Q: according to EN 10025-6). The plates are delivered with sheared or thermally cut edges.

TOLERANCES

The thickness tolerances of LiftHi 960 meets and exceeds the thickness tolerance of EN 10029 Class A (**). Tolerances on shape, length and width meet the requirements of EN 10029. Flatness tolerances conforms to EN 10029 Class S, or closer. For more information,consult the Leong Jin catalogue: General Product Information.

SURFACE CONDITION AND PROPERTIES

The delivered surface finish meets and exceeds that of EN 10163-2 Class A Subclass 3.

The plates will be delivered as painted, using a low zinc silicate corrosion protective shop primer. Plates can also be delivered as unpainted.

HEAT TREATMENT

LiftHi 960 is not designed for applications requiring working or service temperatures above 550°C. If exceeding this temperature, the mechanical properties of the steel can no longer be guaranteed.

PROCESSING PERFORMANCE

More information on the steel processing performance of LiftHi 960 can be found by consulting the LiftHi 960 Technical manuals on 1) Bending, 2) Welding, 3) Cutting and 4)Machining.

(*) According to EN 10025-1, In plate thickness less than 12 mm, subsize Charpy test samples are used. The specified min value is then proportional to the cross section of the sample. Impact tests are not required for nominal thickness < 6 mm.

(**) In the range of 4.0 – 12.0 mm the Leong Jin thickness tolerances can be offered.

LiftHi 1100

Revision:01

CHARACTERISTICS

LiftHi 1100 is a fully martensitic Q&T ultra high strength structural steel plate. LiftHi 1100 provides a very good weldability and is well suited for cold forming operations.

APPLICATIONS

LiftHi 1100 is used in various types of lifting appliances such as mobile and truck crane boom sections and other types of outriggers.

DIMENSIONS

LiftHi 1100 is supplied in the thickness range of 4.0 - 12.0 mm and in plate width of 900 – 3 100 mm and in plate length from 3 000 to 18 000 mm.

TENSILE PROPERTIES

Yield strength Rp0.2, min	Tensile strength Rm	Elongation A5, min
1100 MPa	1250-1550 MPa	10%

Uniaxial tensile testing is performed in the transverse direction to rolling according to EN ISO 6892-1.

IMPACT TOUGHNESS

Min 27J/-40 °C (-40 °F)

The impact toughness is given as absorbed energy at temperature being the average of three full size Charpy-V test samples in transverse direction to rolling, according to EN ISO 148-1 (*)

CHEMICAL COMPOSITION

Ladle analysis: The steel is grain refined and fully killed, wt%

Thickness (mm)	C max	Si max	Mn max	P max	S max	Cr max	Ni max	Mo max	B max	CEV Typical	CET Typical
4.0 – 12.0	0.20	0.60	1.50	0.020	0.010	0.80	1.50	0.80	0.004	0.59	0.36

$$\text{CET} = C + \frac{Mn + Mo}{10} + \frac{Cr + Cu}{20} + \frac{Ni}{40} \qquad \text{CEV} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

ULTRASONIC TESTING

All plates delivered meets the Class E2, S2 requirement, according to EN 10160.

DELIVERY CONDITION

LiftHi 1100 is delivered as quenched and tempered (QT). (Q: according to EN 10025-6).
The plates are delivered with sheared or thermally cut edges.

TOLERANCES

The thickness tolerances of LiftHi 1100 meets and exceeds the thickness tolerance of EN 10029 Class A (**). Tolerances on shape, length and width meet the requirements of EN 10029. Flatness tolerances conforms to EN 10029 Class S, or closer. For more information, consult the Leong Jin catalogue: General Product Information.

SURFACE CONDITION AND PROPERTIES

The delivered surface finish meets and exceeds that of EN 10163-2 Class A Subclass 3.

The plates will be delivered as painted, using a low zinc silicate corrosion protective shop primer. Plates can also be delivered as unpainted.

HEAT TREATMENT

LiftHi 1100 is not designed for applications requiring working or service temperatures above 200°C. If exceeding this temperature, the mechanical properties of the steel can no longer be guaranteed.

PROCESSING PERFORMANCE

More information on the steel processing performance of LiftHi 1100 can be found by consulting the LiftHi 1100 Technical manuals on 1) Bending, 2) Welding, 3) Cutting and 4)Machining.

(*) According to EN 10025-1, In plate thickness less than 12 mm, subsize Charpy test samples are used. The specified min value is then proportional to the cross section of the sample. Impact tests are not required for nominal thickness < 6 mm.

(**) In the range of 4.0 – 12.0 mm the Leong Jin thickness tolerances can be offered.

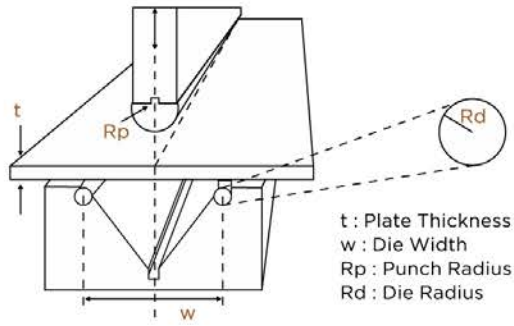
TECHNICAL MANUAL

Bending | Welding | Cutting | Machining

LiftHi 700 Technical Manual

BENDING

LiftHi 700 is produced to meet the high customer demands on formability, tolerance accuracy and productivity. The steel compositions and processing procedures used for LiftHi 700 have been carefully tuned to obtain the very best performance in terms of cold forming capability. Close thickness tolerances, consistence of the through-thickness properties, together with an excellent surface finish, are properties that promotes a reproducible spring back, bending to narrow radius and having a high crack resistance during forming operations.



Tool Geometry: To secure a complete plate to punch tool contact throughout the bending operation, it is recommended that the head of the punch tool is designed to have a semicircular geometry.

Direction of Rolling: The bending properties transverse to rolling direction is always more favorable compared to bending in a longitudinal direction. Thus, the bending recommendations, displayed in Table 1, shows two sets of R/t-ratios.

Bending Recommendations: Min. recommended punch tool radius (R) when bending to an angle of 90° in either the transverse direction or the longitudinal direction to rolling.

Table 1. LiftHi 700 Bending Recommendations

Min Bending Tool Radius, mm		
Thickness (t, mm)	**Transverse**	**Longitudinal**
$4.0 \leqslant t < 15.0$	1.5 x t	2.0 x t
$t \geqslant 15.0$	2.0 x t	2.5 x t

Table 2. Recommended Die Opening (W) in respect to Plate Thickness (t) when bending 90°

Steel Grade	Die Opening
LiftHi 700	t X 12-16

By having a narrow spread in tensile properties and thickness tolerance, the consistency in spring back is improved, boosting the bending reproducibility.

WELDING

LiftHi 700 is produced based on a low-alloy steel concept, granting an excellent weldability. By this, the carbon equivalents (CEV/CET), can be kept low in respect to strength and the plate thickness. Combined with an excellent impact toughness, the crack resistance in welds always meet the high demands that is reflected on the steel weldability. LiftHi 700 can be welded using any of the conventional welding methods.

To obtain a proper weld quality, it is recommended to apply good weld hygiene by keeping the joint clean from moisture, oil and scale from cutting (according to EN 1011). To secure this, always perform bevel preparation by milling the edge and respect the guidelines given in this manual.

Heat Input Recommendations

Calculation of welding Heat Input:
$Q(kJ/mm) = [U \times I \times 60 \times k] / [v \times 1000]$

The max. recommended Heat Input (Q) in relation to plate thickness (t) for welding LiftHi 700 is given by the following expressions:

Plate Thickness: 4 – 25 mm
$Q_{max} = 0.14 \times t$

Plate Thickness: > 25 mm
$Q_{max} = 3.5$ kJ/mm

Thermal Efficiency Factor, k

Manual Metal Arc (MMA)	k= 0.8
Gas Metal Arc (GMAW)	k= 0.8
Flux Cored Arc (FCAW)	k= 0.9
Metal Cored Arc (MCAW)	k= 0.9
Submerge Arc Welding (SAW)	k= 1.0

Using a too high Heat Input risks the strength and impact toughness of the heat affected zone to be affected.

Another way to control the weld parameters for not jeopardizing the heat affected zone strength and toughness is to put restrictions on $\Delta t8/5$*. When welding LiftHi 700, the weld parameters should be selected in a way not allowing $\Delta t8/5$ to exceed 24 seconds.

* $\Delta t8/5$ is the time for the weld deposit to cool down from 800°C to 500°C.
$\Delta t8/5$ = f (Heat Input, Plate thickness, Preheat/Interpass temperature)
$\Delta t8/5$ can be measured or calculated according to EN 1011-2.

Q- Heat Input (kJ/mm) v- Welding Speed (mm/min) U – Voltage (V) k- Thermal Efficiency Factol I- Current (A)

Hydrogen Cracking

To prevent hydrogen cracks to develop in welds of LiftHi 700, the following aspects should be considered:

- Always use electrode of low hydrogen style, not exceeding 5 ml/100 g weld metal deposit.
- Try to position welds in low stressed areas.
- Secure good fitting of the parts to be welded.

No Preheat Requirements

To eliminate the risk of developing cracks in the welds of LiftHi 700,it is recommended to apply heating at 100℃ when welding single plate thickness from 30 mm and up.

Depending on air humidity and/or the location where the plates are stored, it is recommended to dry off the area to be welded using a flame torch or similar. This is to allow dampness and moisture that is stuck on the plate surface to be released prior to start welding.

Recommended max. interpass temperature for multipass welding LiftHi 700, is 350℃

Electrode Selection

- Welding LiftHi700 should be performed using low alloy ferritic electrodes, granting low hydrogen pick up.
- Always select electrodes where the supplier guarantees weld metal hydrogen content of ⩽5 ml/100g.
- To secure low hydrogen content in flux based electrodes, it is very important the electrode handling instructions given by the electrode supplier are respected. Always select a basic flux system.

When selecting the strength of the electrode, the requirements is usually governed by the construction standards.

If the strength of weld should meet the same requirements as the steel itself, electrodes of matching or slightly overmatching strength should be used. This means that the yield strength of the weld metal should be at the same level or slightly higher (⩾700 MPa), compared to the minimum strength of the parent material.

In the table below, electrode classes have been listed suitable for Welding LiftHi 700, depending on welding method used.

Ferritic Electrodes for Welding LiftHi 700					
Class	MMA (Manual Metal Arc)	GMAW (Gas Metal Arc)	FCAW (Flux Cored Arc)	MCAW (Metal Cored Arc)	SAW (Submerged Arc)
EN ISO	757 E 69X	12534 G 69X	18276 T69X	12535 T 69X	14295 S 69X
AWS	A5.5 E100X A5.5 E110X	A5.28 ER1 OOS-X A5.28 E110C-X	A5.29 E1 OXT -X A5.29 E11XT-X	A5.28 E11 OC-X	A5.23 F10X A5.23 F11X

X – Substitute one or several additional digits

Shielding Gas : When using either of the welding methods GMAW, FCAW or MCAW, a shield gas mix of Ar + 15-25% CO_2 is recommended.

CUTTING

LiftHi 700 high strength structural steel can be cut by any means of thermal cutting or cold cutting methods, in the very same way as cutting mild steel.

Plasma cutting, Flame cutting or Laser cutting can be performed the same way as cutting of conventional steel grades.

To reach an optimal cut edge quality when laser cutting LiftHi 700 that has a primer coated surface, it is recommended to reduce the cutting speed by 5 – 10% compared to laser cutting on a non-primer coated surface.

General Recommendations on Thermal Cutting LiftHi 700:

- Independent of which thermal cutting method is used, the cut parts should always be allowed to cool slowly after finished cutting. Do not use accelerated cooling for cut parts.
- Before the start of thermal cutting, let the LiftHi 700 plate reach an ambient temperature of min 0℃

MACHINING

Drilling

LiftHi 700 can be drilled using either High Speed Steel (HSS) or cemented carbide drills. The kind of drills to use depends on the drilling machine stability and drill diameter.

Usually radial or column drilling machines allow substantial vibrations, that is why drills made of High Speed Steel (HSS) are recommended to be used.

When using HSS-drills in the diameter range from 5 mm to 30 mm, either micro alloyed (HSS-E) drills or 8%-Cobalt containing drills (HSS-Co) should be selected, having a small helix which can withstand high torques.

Due to the high re-grinding frequency of HSS-drills, the productivity becomes low when processing Q&T steels. To reach high productivity machining, modern and stable drilling/milling machines (CNC-type) have to be used, as well as the use of cemented carbide type of drills/milling tools.

For high productivity drilling operation, the most economical type of drill to use is a tool that has cemented carbide indexable inserts. This tool consists of cemented carbide cutting edges mounted into a tool. The hole diameter of this kind of tool ranges from 12 mm and up.

For smaller hole diameters (ø < 12mm), solid cemented carbide drills must be used.

Milling

Depending on the kind of milling operation to be conducted the following recommendations are given:

- For face milling: Use a tool that has round cemented carbide inserts.
- For finish milling: Use a tool that has cemented carbide inserts with a 45° cutting angle
- For end milling: Use either solid cemented carbide tools or tools with cemented carbide inserts.

Counterboring and countersinking are best performed using tools equipped with cemented carbide inserts and rotating pilot.

General Recommendations

- For all machining operations, proper clamping of work piece is required.
- Cooling lubricants should always be used when machining LiftHi 700 steel grades.
- For best performance, always try to use cemented carbide tools with internal cooling system.

LiftHi 900 Technical Manual
LiftHi 960 Technical Manual

LiftHi 900 and LiftHi 960 are fully martensitic quenched and tempered steel plates, holding a minimum yield strength of 900 MPa and 960 MPa, respectively.

Both products are designed to provide excellent formability and weldability, combined with high strength and impact toughness.

As all Q&T steel grades are produced by Leong Jin Special Steel, LiftHi 900 and LiftHi 960 are based on iron ore metallurgy and advanced clean steel making practices in order to ensure low contents of residuals and impurities in the steel.

Applying accurate and balanced heat treat processes, by quenching and tempering, the mechanical properties obtained can be kept consistent and assuring low levels of residual stresses.

Both LiftHi 900 and LiftHi 960 conform to S890QL and S960QL (according to EN 10025-6) respectively but offers closer tolerances overall, a higher guaranteed impact toughness and the possibility to reach close bending radius.

Other features to be highlighted are the excellent flatness of the plates, complying with EN 10029- Special tolerances, and the excellent surface quality of the plates.

Due to the high strength of thd steel, the final application can be designed to be not only strong but also lightweight, which results in substantial reductions in cost of materials and workshop processing.

The application segments in which LiftHi 900 serves is most commonly found within heavy truck chassis, out riggers, concrete pump trucks, and various different lifting and handling equipment. Whereas LiftHi 960 is frequently found in applications related to lifting and handling, such as mobile and truck crane boom sections.

By substituting steels of lower strength with our LiftHi products, the lifting capability of applications can be increased by many folds.

For further information concerning the properties of LiftHi 900 and LiftHi 960, please consult the respective product data sheets.

BENDING

Considering the frequent use of LiftHi 900 and LiftHi 960 for manufacturing crane boom sections, it is obvious that the bending performance is an essential property of the steel. Therefore, when designing our LiftHi products, special attention was given to manufacture plate that allowed bending to narrow radius.

By keeping the thickness tolerances close, consistent through-thickness properties and an excellent surface finish, the formability of steel will be boosted, ensuring reproducible spring back, bending to narrow radius and crack resistance through the entire forming operation.

To utilize full performance of the plate formability, proper engineering workshop techniques must be applied. Worn punch tools, poor friction between die edges and plates, surface defects and poor cut edge qualities may all impact against the final result after bending.

In Tables 1 and 2, the bending recommendations for LiftHi 900 and LiftHi 960 are shown, also addressing the minimum bending radius with respect to plate thickness and rolling direction.

Table 1. Bending Recommendations LiftHi 900/960

	Min Bending Tool Radius, mm	
Thickness (t, mm)	**Transverse**	**Longitudinal**
$4.0 \le t < 20.0$	2.5 x t	3.0 x t
$t \ge 20.0$	3.0 x t	3.5 x t

The smallest bending radius is reached if bending in the transverse direction to rolling.

Table 2. Recommended Die Opening (W) with respect to plate thickness

Steel Grade	Die Opening
LiftHi 900/960	t x 12 -16

The springback increases by the steel strength and the width of die (W). Other factors inflencing the springback are the punch tool radius, actual thickness of plate and friction between plate and bending tools.

LiftHi 900

LiftHi 960

WELDING

LiftHi 900 and LiftHi 960 can easily be welded by using any of the conventional welding methods, including laser welding.

To obtain the full capacity in welds of both LiftHi 900 and LiftHi 960, it is very important to follow the guidelines given below, which are 1) choice of consumables, 2) weld heat input and 3) requested of preheating.

When welding high strength Q&T steel grades, attention must be given to maintain good weld hygiene during the welding process and to keep the weld joint free from rust, grease/oil, dirty and moisture.

Welding consumables

The weld electrode used should be selected according to the requirements set by the structural standard used. When welding LiftHi 900 and LiftHi 960, using electrodes.

of matching strength is recommended. This means that the strength of the deposited weld metal should meet the minimum strength as specified by the parent material.

Consumables selected for welding LiftHi products should be of low hydrogen style, granting a maximum hydrogen content of ⩽ 5 ml/ 100 g weld metal.

If electrodes of under matched strength are used, the strength transverse the weld will be controlled by the strength of the weld metal, and not the HAZ or parent material. Thus, the usage of under matched consumables will always produce a weld of lower strength in comparison to the parent material.

In Table 3, the AWS and EN ISO electrode classes are listed in accordance to the suitable electrodes to be used when welding LiftHi 900 and LiftHi 960, in respective to the weld method.

Table 3. Low alloy ferritic electrodes for welding LiftHi 900/960

Class	MMA (Manual Metal Arc)	GMAW (Gas Metal Arc)	FCAW (Flux Cored Arc)	MCAW (Metal Cored Arc)	SAW (Submerged Arc)
EN ISO	757 E 89X	16384 89X	18276 T 89X	18276 T 89X	26304 S 89X
AWS	A5.5 E120X	A5.28 ER120-X	A5.29 E12XT-X	A5.28 E120C-X	A5.23 F12X

X – Substitute one or several additional digits

Shielding Gas: When using either of the welding methods GMAW, FCAW or MCAW a shield gas mix of Ar + 15 - 25% CO_2 is recommended.

Handling of welding consumables: It is essential the welding consumables are protected against moisture during handling and storage, and condensation of water to occur on the electrodes. If advised by the electrode supplier, the electrode/flux should be dried before use.

Heat Input

By introducing restrictions on the heat input used when welding, both strength and extension of the heat affected zone (HAZ) can be controlled. The higher the weld heat input used, the wider the soft zone will be developed in the HAZ. If welding is done using too high heat input , the strength of the HAZ will become the limiting factor, thus reducing the strength transverse the weld.

Calculation of welding Heat Input:

$$Q = [U \times I \times 60 \times k] / [v \times 1000]$$

Q - Heat Input (kJ/mm)
U - Voltage (V)
I - Current (A)
v - Welding Speed (mm/min)
k - Thermal Efficiency Factor

Thermal Efficiency Factor, k

Manual Metal Arc (MMA)	k= 0.8
Gas Metal Arc (GMAW)	k= 0.8
Flux Cored Arc (FCAW)	k= 0.9
Metal Cored Arc (MCAW)	k= 0.9
Submerge Arc Welding (SAW)	k= 1.0

The maximum recommended Heat Input (Q) in relation to the plate thickness (t) for welding LiftHi 900 and LiftHi 960 is given by the expressions below:

Plate Thickness: 4 – 25 mm
Q max = 0.10 x thickness (mm)

Plate Thickness: > 25 mm
Q max = 2.5 kJ/mm

Another way to control the weld parameters for not jeopardizing the heat affected zone strength and toughness is to use Δt8/5*. When welding LiftHi 900 and LiftHi 960, the Δt8/5 should not exceed 15 seconds.

* Δt8/5 is the time for the weld deposit to cool down from 800°C to 500°C.
Δt8/5 = f (Heat Input, Plate thickness, Preheat/Interpass temperature)
Δt8/5 can be measured or calculated according to EN 1011-2.

Preheat Requirements

To eliminate the risk of developing cracks in the weld of LiftHi 900 and LiftHi 960, it is recommended to apply preheating at 100°C when welding single plate thickness from 15 mm and above.

Depending on the air humidity and/ or the location where the plates are stores, it is recommended to dry the area to be welded using a flame torch or similar. This is to ensure the dampness and moisture that is stuck on the plate surface to release prior to the start of welding.

The recommended maximum interpass temperature for multipass welding both LiftHi products is 325°C.

CUTTING

Both LiftHi 900 and LiftHi 960 are well suited for cutting using either thermal or cold cutting methods.

When performing Plasma cutting, Flame cutting or Laser cutting, no special considerations has to be taken with respect to preheating or cutting speed and can be performed in the same way as cutting commercial mild steel.

To optimize cut quality when performing laser cutting on a primer coated plate surface, the cut edge quality may sometimes be improved if the cutting speed is reduced by 5 – 10%, as compared to cutting a non-primer coated surface.

- Independent of which thermal cutting method is used, the cut parts should always be allowed to cool down slowly after cutting has finished.
- Do not use accelerated cooling of cut parts.
- Before the start of thermal cutting, allow the plate to reach an ambient temperature of minimum 0°C.

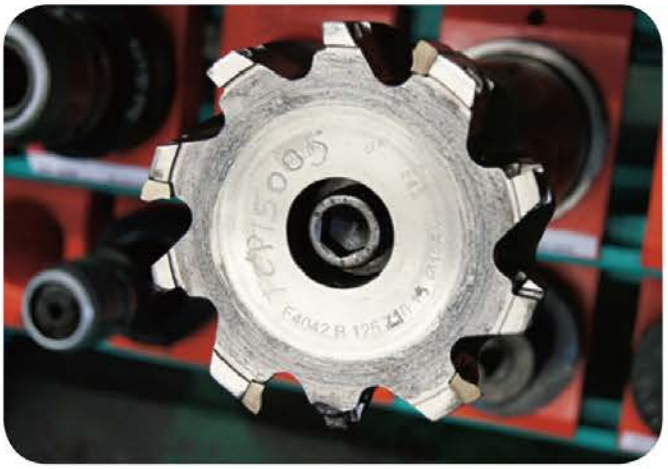
MACHINING

LiftHi 900 and LiftHi 960 can be machined by drilling, milling, turning, counterboring or countersinking.

Drilling can be performed using either 8% Co High Speed Steel (HSS) or cemented carbide drills. The kind of drills to use depends largely on the drilling machine stability and drill diameter.

For high productivity of the drilling and milling operations, the most economical type of tool to use is one that has cemented carbide indexable inserts. This tool consists of cemented carbide cutting edge that are mounted into the tool.

When drilling, the diameter of indexable tool ranges from 12 mm and above. For smaller diameters (ø < 12 mm), solid cemented carbide drills must be used.



LiftHi 1100 Technical Manual

The ever-growing lifting and handling industry has ongoing requirements for stronger, lighter and more reliable structural steel, for manufacturing various types of cranes, hoisting and lifting equipment.

By applying modern steel making quenching and tempering techniques, it is possible to produce high strength steel with up to 1100 MPa in yield strength. This high strength steel gives potential for considerable improvements in performance and reduction of weight, which is of increasing importance within the construction industry sector.

To exploit the full potential of 1100 MPa steel, design philosophy and production techniques requires taking into account factors such as plate formability, weldability, stiffness and fatigue resistance.

When manufacturing a steel that holds a yield strength of 1100 MPa, very high demands are put on the steel making, to apply a clean steel making practice that grants low levels of impurities and inclusions inside the steel. Except for this, the heat treatment of the plate must be carried out in a very precise and accurate manner, securing consistent mechanical properties, flatness and low residual stresses.

Due to this, only a handful of the world Q&T producers can present 1100 MPa steel in their product portfolio.

LiftHi 1100 is a fully martensitic fine grain treated plate produced by water quenching and tempering, holding a min yield strength of 1100 MPa and a guaranteed toughness of -40℃

In respect of its strength, LiftHi 1100 provides good impact toughness as well as welding and cold forming properties.

By using iron ore based metallurgy and advanced secondary metallurgy clean steel making practices, steel containing low levels of residuals and impurities can be ensured.

The targeted applications segment for LiftHi 1100 stays within the lifting industry, such as crane boom segments for mobile and truck cranes.

BENDING

To utilize the full performance of the plate formability, proper engineering workshop techniques must be applied. Worn punch tools, poor friction between die edges and plates, surface defects and poor cut edge quality may all impact on the final result after bending.

In tables 2 and 3, the bending recommendation for LiftHi 1100 is given, addressing the minimum bending radius in respect to plate thickness and direction to rolling, bending to 90°

Table 2. LiftHi 1100 Bending Recommendations

	Min Bending Tool Radius, mm	
Thickness (t, mm)	Transverse	Longitudinal
4.0 ≤ t ≤ 12.0	3.0 x t	3.5 x t

Table 3. Recommended Die Opening (W) in respect to Plate Thickness (t) when bending 90°

Steel Grade	Die Opening
LiftHi 1100	t x 12 -16

WELDING

Welding Consumables

The weld electrode should be selected according to the requirements set by the structural standard used. When welding LiftHi 1100, electrodes of matching strength are very difficult to find out, thus electrodes of under matching strength have to be used. To reach a high transverse weld strength, it is recommended to use electrodes having a yield strength in the range of 890 – 950 MPa.

Consumables selected for welding LiftHi 1100 should be of low hydrogen style, granting a max hydrogen content of 5 ml / 100 g weld metal.

In table 1, the AWS and EN ISO electrode classes are listed for suitable electrodes to be used when welding LiftHi 1100, in respect to weld method.

Table 1. Low alloy ferritic electrodes for welding LiftHi 1100					
	Min Bending Tool Radius, mm				
Class	MMA Manual Metal Arc	GMAW Gas Metal Arc	FCAW Flux Cord Arc	MCAW Metal Cored Arc	SAW Submerged Arc
EN ISO	757 E 89X	16384 89X	18276 T 89X	18276 T 89X	26304 S 89X
AWS	A5.5 E120X	A5.28 ER120-X	A5.29 E12XT-X	A5.28 E120C-X	A5.23 F12X

X – Substitute one or several additional digits

Shielding Gas	When using either of the welding methods GMAW, FCAW or MCAW a shield gas mix of Ar + 15-25% CO_2 is recommended.

Heat Input

By introducing restrictions on Heat Input used when welding, the strength and extension of the heat affected zone (HAZ) can be controlled.

The max recommended Heat Input (Q) in relation to plate thickness (t) for welding LiftHi 1100 is given by the expressions below:
Calculation of Welding Heat Input:
Q = [u x I x 60 x k] / [v x 1000]
Plate thickness: 4 – 12 mm
Q max = 0.08 x thickness (mm)

Another way to control the weld parameters for not jeopardizing the heat affected zone strength and toughness, is to use the △t8/5. When welding LiftHi 1100, the t8/5 should not exceed 12 seconds.

Q- Heat Input (kJ/mm) U-Voltage (V) I-Current (A)
v- Welding Speed (mm/min) k- Thermal Efficiency Factor

Thermal Efficiency Factor, k

Manual Metal Arc (MMA)	k=0.8
Gas Metal Arc (GMAW)	k=0.8
Flux Cored Arc (FCAW)	k=0.9
Metal Cored Arc (MCAW)	k=0.9
Submerge Arc Welding (SAW)	k=1.0

Preheat Requirements

To eliminate the risk of developing hydrogen cracks in the welds of LiftHi 1100, it is recommended to apply preheating at 100℃ when welding single plate thickness from 12 mm and up.

Depending on air humidity and/or the location where the plates are stored, it is recommended to dry off the area that is to be welded using a flame torch or similar. This is to allow dampness and moisture that is stuck on the plate surface to be released prior to start welding.

Recommended max. interpass temperature for multipass welding is 225℃

CUTTING

LiftHi 1100 is well suited for cutting using either thermal or cold cutting methods.

When performing Plasma cutting, Flame cutting or Laser cutting, no special considerations needs to be taken in respect to preheating or cutting speed, so cutting can be performed in the same way as cutting commercial mild steel.

To optimize the cut quality when performing laser cutting on a primer coated plate surface, the cut edge quality may sometimes be improved by reducing the cutting speed by 5 – 10%, compared to cutting a non-primer coated surface.

MACHINING

LiftHi 1100 can be machined by drilling, milling, turning, counterboring or countersinking.

For high productivity drilling and milling operation, the most economical type of tool to use is a tool that has cemented carbide indexable inserts.

LEONG JIN CORPORATION PTE LTD

No.11, Benoi Crescent, Jurong Industrial Estate,
Singapore 629974
Tel: (65) 6266 1132
Fax: (65) 6268 2090, 6266 1529
Email：admin_LJSS@leongjin.com.cn

www.leongjin.com.sg