TG Steels

TGE11

CUDA ESR

Electroslag Remelted *(ESR)* hot work tool steel with good combination of toughness and hot properties for general hot work applications

TGE 11 CUDA ESR;

- is an Electro Slag Remelted *(ESR)* 5% Cr steel that ensures a very high level of cleanliness and homogeneity.
- has a very good toughness and ductility associated with a good enough hot strength and tempering back resistance.
- has a very good polishability, is good for texturing.
- can be used for applications requiring a mirror polished level *(Rt ≤ 0.25 µm, CNOMO level 1, Rugotest N1)*.
- can also be welded and exhibits good machinability.
- can be hardened up to 54 HRCafter the heat treatment and the recommended working hardness is 44 - 52 HRC.
- has a very good suitability for surface tr eatments such as gas, ionic or salt bath nitriding, as well as PVD or CVD coatings.

Applications

TGE 11 CUDA ESR can be used for all press forging dies and cores, precision plastic injection molds with a high level of polishability, molds for abrasive polymers and reinforced plastics, low pressure die casting dies, secondary areas in die casting dies such as biscuit and runner, shot sleeve in HPDC.

TGE 11 CUDA ESR can also be used for industrial knives & blades resistant to cracking and breaking. Punches, cutting and shearing blades thicker than 10 mm.

Main properties

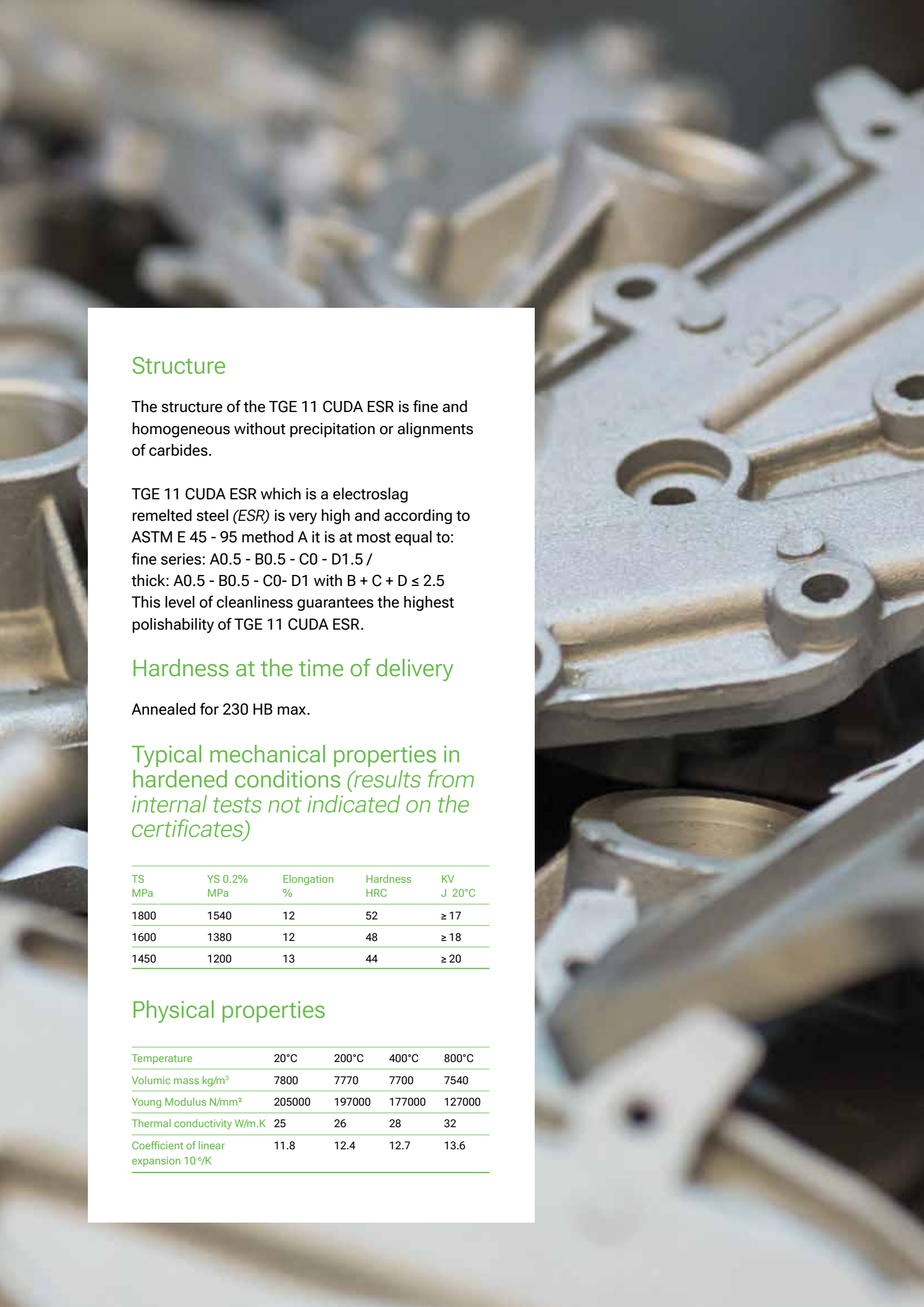
- Very good toughness and ductility
- Excellent polishability
- Good hot strength and tempering back resistance
- High hardenability
- Suitable for surface treatments

Chemical composition *(typical)*

C	Mn	Si	P	S	Cr	Mo	V
0.37	0.37	1.00	< 0.020	< 0.005	5.15	1.30	0.40

Designation

Werkstoff Nr	ISO	China GB	JIS Japan	UK	AISI USA	Russia Gost	AFNOR	Other / Special
1.2343 ESR	X37CrMoV5-1	4Cr5MoSiV1	SKD6	BH11 ESR	H11 ESR	-	-	NADCA Grade D



Structure

The structure of the TGE 11 CUDA ESR is fine and homogeneous without precipitation or alignments of carbides.

TGE 11 CUDA ESR which is a electroslag remelted steel *(ESR)* is very high and according to ASTM E 45 - 95 method A it is at most equal to:
fine series: A0.5 - B0.5 - C0 - D1.5 /
thick: A0.5 - B0.5 - C0- D1 with B + C + D ≤ 2.5
This level of cleanliness guarantees the highest polishability of TGE 11 CUDA ESR.

Hardness at the time of delivery

Annealed for 230 HB max.

Typical mechanical properties in hardened conditions *(results from internal tests not indicated on the certificates)*

TS MPa	YS 0.2% MPa	Elongation %	Hardness HRC	KV J 20°C
1800	1540	12	52	≥ 17
1600	1380	12	48	≥ 18
1450	1200	13	44	≥ 20

Physical properties

Temperature	20°C	200°C	400°C	800°C
Volumic mass kg/m^3	7800	7770	7700	7540
Young Modulus N/mm²	205000	197000	177000	127000
Thermal conductivity W/m.K	25	26	28	32
Coefficient of linear expansion 10^{-6}/K	11.8	12.4	12.7	13.6

Heat treatment

SOFT ANNEALING

Temperature: 750 - 800°C, duration 1h + 1h for 25 mm thickness. slow cooling in the furnace *(10 to 20°C/h)*. The atmosphere in the furnace must be reducing to avoid decarburization of the steel.

STRESS RELIEVING

After machining, it is recommended to perform stress relieving at 600 - 650°C for a minimum of 2 hours, followed by slow cooling in the furnace to 450°C.

AUSTENITIZATION

In order to avoid any risk of cracking it is recommended to preheat in 2 steps.

- 1st preheating step:
  temperature: 550°C time: 30 s/mm of thickness
- 2nd preheating step:
  temperature: 750°C time: 30 s/mm of thickness

Recommended austenitizing temperature: 1000 - 1040°C. The holding time should not be too long to avoid a risk of grain coarsening and a loss of toughness. It is recommended to keep the part at the austenitizing temperature 30 minutes per inch of thickness as soon as the temperature of the surface reach the austenitization temperature.

QUENCHING MEDIUM

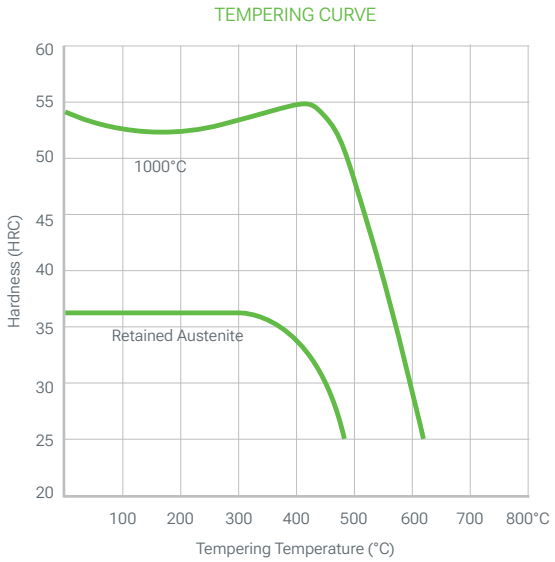
Oil at 80°C, vacuum *(pressure > 6 bars)*, salt bath 500 - 550°C.
To ensure good toughness, treatment with oil or salt bath is preferable.

SUB ZERO TREATMENT

For parts used in cold work applications that need to have high dimensional stability and to increase wear resistance without reducing toughness, it is recommended to perform a subzero treatment at a temperature between -70°C and -190°C for 1 hour for 25 mm of thickness of the part.

The temperature range from -70°C up to -120°C *(named cold treatment of steel)* leads to the complete transformation of austenite into martensite and as a consequence to better stability associated with improved hardness and better wear resistance and the temperature range from -135°C down to -190°C *(named cryotreatment of steel)* leads also to the complete transformation of austenite and also the precipitation of ultrafine carbides improving a lot the wear resistance without modification of the toughness.

This treatment is optional for common applications.



TEMPERING

To ensure a minimum residual austenite rate as well as greater tool stability, it is essential to perform a double tempering. Each tempering is followed by a cooling under 100°C.

Each tempering time must be at least equal to 1h + 1h for 25 mm of thickness of the treated part *(equivalent thermal thickness).*

Surface treatment

NITRIDING

TGE 11 CUDA ESR can be nitrided at temperatures less than or equal to 20°C below tempering temperatures without risk of deterioration of the mechanical characteristics.

With gas nitriding at 520°C *(25h)* the surface hardness is 1080 HV1 with a diffusion layer of 0.2 mm.

PVD, CVD

TGE 11 CUDA ESR is suitable for all kinds of PVD and CVD treatment as soon as the treatment temperature is 30°C lower than the last tempering temperature.

Texturing

TGE 11 CUDA ESR is suitable for chemical or laser texturing.

Machining

The machining parameters below are given for information only and must be adapted according to the equipment and usual machining conditions.

TURNING

	Carbide tool		HSS tool
	Rough machining	Finishing	Finishing
Cutting speed m/min	130 - 170	170 - 220	17 - 22
Feed mm/r	0.2 - 0.4	0.1 - 0.2	0.1 - 0.3
Depth of cut mm	2 - 4	0.5 - 2	0.5 - 2

MILLING: SURFACING

	Milling with carbide tools		Solid tool
	Rough machining	½ Finishing	Finishing
Cutting speed m/min	160 - 180	180 - 200	210 - 280
Feed mm/r	0.4	0.35 - 0.25	0.10 - 0.05
Depth of cut mm	1 - 3	1 - 2	1 - 0.5

DRILLING: HSS TWIST DRILL

Drill diameter mm	Cutting speed m/min	Feed mm/t
< 5	14 - 16	0.05 - 0.15
5 - 10	14 - 16	0.15 - 0.20
10 - 15	14 - 16	0.20 - 0.25
15 - 20	14 - 16	0.25 - 0.30

DRILLING: CARBIDE DRILL

		Carbide type	
	Indexable insert	Solid carbide	Carbide tip
Cutting speed m/min	160 - 180	100 - 130	55 - 80
Feed mm/t	0.05 - 0.10	0.10 - 0.25	0.15 - 0.25

FINE GRINDING

General indications for grinding wheels to be used on CUDA PRIME in the heat treated condition.

Usually, rather soft vitrified aluminum oxide grinding wheels *(grades G for plane grinding to K for cylindrical grinding)* are used.

Particular attention will be paid to effective cooling of the surface during grinding to prevent degradation of the material surface.

ELECTRO-DISCHARGE MACHINING

TGE 11 CUDA ESR is also suitable for EDM machining *(wire or electrode)*. Preferably, the machining will be carried out with a low current density and a high frequency in order to limit the thickness of the white layer as much as possible.

Then it is necessary to carry out a stress relieving at 25°C below the last tempering in order to reduce the level of residual stresses *(which could lead to a risk of cracking)* and to carry out a polishing to completely remove the white layer formed during the discharge machining process.

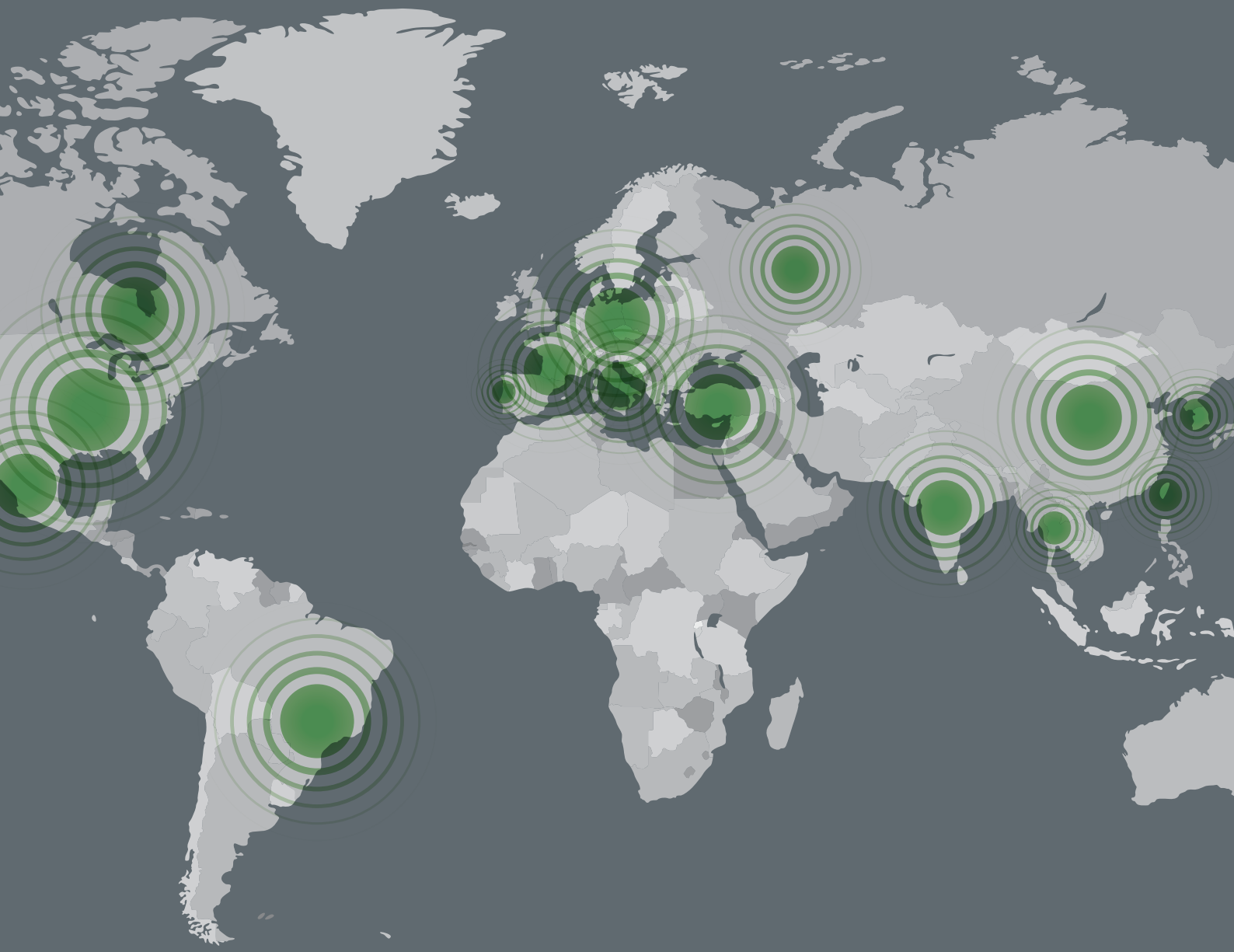
Welding

It is not recommended to weld TGE 11 CUDA ESR but if this is mandatory it could be welded either in the annealed condition *(better)* or in the heat treated condition.

- Method: TIG
- Feeder wire: AISI H11 *(in order to avoid any porosity it is recommended to preheat the wire at 105 - 115°C before welding)*.
- Preheating: 350°C.

Hold at 200°C during the welding operation with a maximum interpass temperature at 480°C. Slow cooling *(max 20°C/h)* after welding.

- Post treatment:
  - In the treated state: tempering at 600°C with a tempering time at least equal to 1h + 1h for 25 mm of thickness of the treated part *(equivalent thermal thickness)*.
  - In the annealed state: carry out a soft annealing under the usual conditions: temperature: 840 - 870°C, duration 1h + 1h for 25 mm of thickness. slow cooling in the furnace *(10 to 20°C/h)*



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