INTERNATIONAL WELDING TECHNOLOGY CENTER IN CHINA

IWTC

CNPC Tubular Goods Research Institute

中信金属 CITIC Metal

CBMM

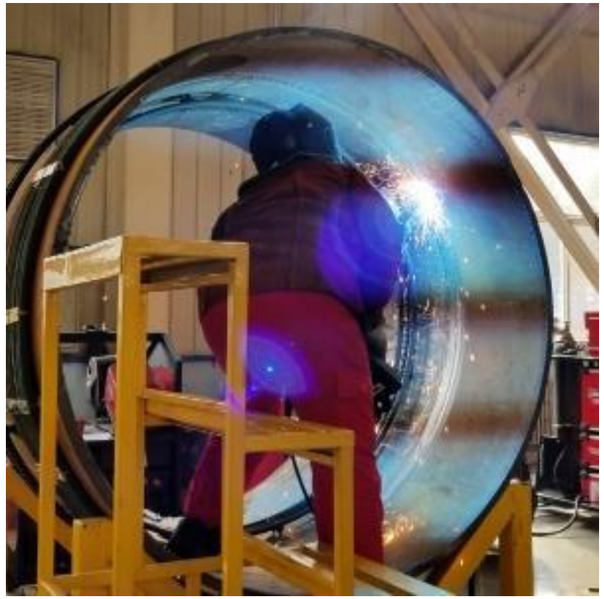
The demand for high efficiency and clean energy started a considerable number of long-distance gas transmission pipelines in China, using higher strength API X80 for pipe with diameters up to 1.422mm. The creation of the International Welding Technology Center, IWTC, was an **initiative from CNPC and its R&D Center TGRI, together with CITIC Metals and CBMM** in order to conduct advanced research on high quality steels using the latest technological equipment and consumables to provide safe and reliable pipeline systems in the world. The IWTC has technical partnership with **University of Wollongong** in Australia and other internationally recognized centers.

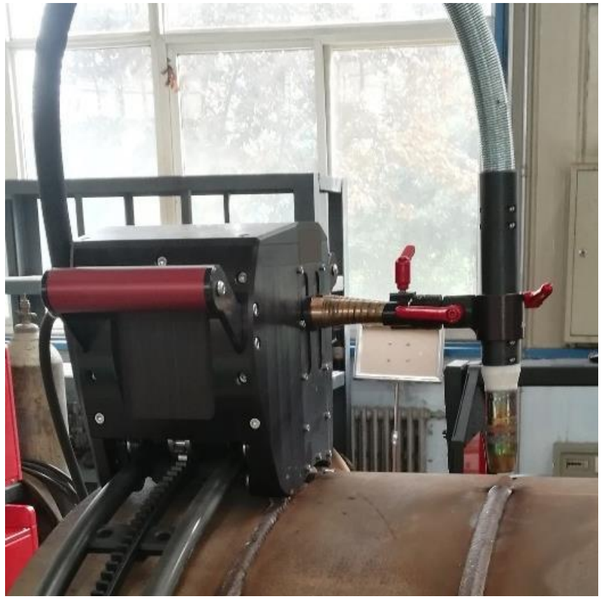
The IWTC is in Xi'an City, Shanxi Province. **The welding center was installed inside TGRI laboratories,** getting the benefits and the synergy of being together with one of the best pipeline R&D Center in China. This strategy was responsible for the very fast commissioning of these activities and for the formation of a very strong team during this short period of time. It has started studying the girth welds due to their criticality for safety. In the field, girth welding conditions are more difficult to control, resulting in the need to have more robust processes and very well-trained technicians for these operations.

The major WELDING EQUIPMENT includes:

GMAW system from Lincoln Electric – Power Wave S500, Helix M85, Apex 3000

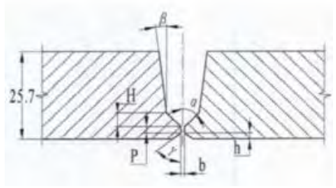
FCAW system from Lincoln Electric & Xionggu – FLEXTEC 500, MPS-500



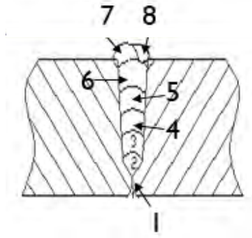


- **The IWTC started studying girth welds for different pipe steels** and after two years of experience, it has proven the capability to provide complete welding process definitions for every pipe design, specifying the joint preparation, the best sequence of welding beads, the specification of the consumables and of all variables included on the welding such as:

- **Current**
- **Travel speed**
- **Voltage**
- **Wire feed rate**
- **Flow rate of shielding gas**, among others



β-=5° ±1.5°
α=45° ± 1.5°
Y=37.5° ±1.5°
P=1.3mm± 0.3mm
H=2.5mm± 0.3mm
h=1.3mm± 0.3mm



Root	Hot	Fill	Cap
1(1)	1(1)	(4-6)(6-12)	1(2)

Joint design & Bevel dimension | Sequence of beads

Joint Preparation & Environment

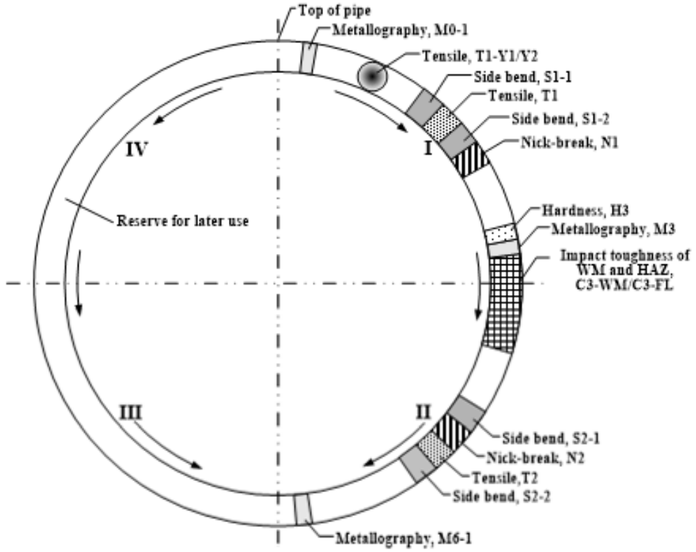
Groove	Misalignment (mm)	Preheat Treatment (or interpass) T (°C)	Environment T/H (°C/%)
Machining and derusting, using emery wheel blades	Misalignment: 0-1.0; Weld gap: 0.5-2.0	Root weld: 120 Hot weld: 80 Filler weld: 60-80 Finish weld: 60-80	≥5; ≤90

	Root weld	Hot weld	Filler weld	Finish weld
Specification	AWS A5.18	AWS A5.18	AWS A5.18	AWS A5.18
Filler metal	ER80S-G	ER80S-G	ER80S-G	ER80S-G
Diameter	Ø1,2mm / Ø1,0mm			
Shielding gas	Ratio	75-80% Ar / 20-25% CO_2		
	Purity	Ar≥99.96%, CO_2 ≥99.5%		
	Moisture content	CO_2 ≤0.0003%		

Weld bead & pass		Polarity	Current (A)	Voltage (V)	Position: 5G Direction	Wire feed rate (in/min)	Travel speed (in/min)	Flow rate of shielding gas (L/min)	Weaving way, width (mm) & stopping time (s)
Root weld	1	DCEP	130-260	18-26	Downward	350-460	25-35	15-25	Stringer
Hot weld	2	DCEN	220-280	20-28	Downward	500-550	45-55	15-30	Stringer
Finish weld	3~N	DCEN	160-220	20-28	Downward	320-450	14-28	15-30	Weave
Finish weld	N+1	DCEN	120-180	20-28	Downward	230-350	14-25	15-30	Stringer

DELIVERABLES OF IWTC

The qualification procedure is vital to ensure the weld and HAZ have the specified properties and the quality necessary to enhance operational security of the pipeline. IWTC starts planning in detail ensuring all testing will meet or exceed the welding requirements.



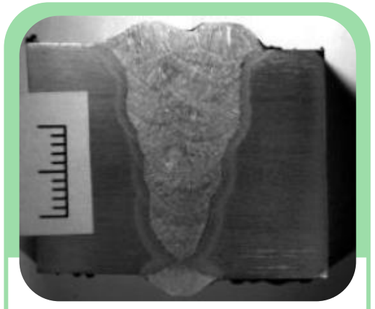
NDT testing: **X ray**

Equipment	X-ray detector- XT3005T	Sample	Girth weld
Irradiation	Center	Photographic density	2.0-3.0
Quality index	9	Test standard	SY/T4109-2013
Test location	TGRI	-	-

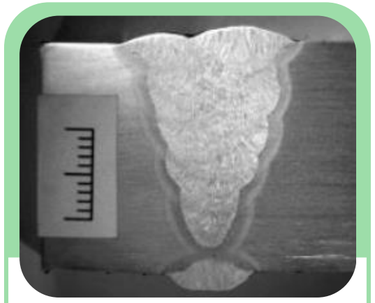
Type of defects:

- Porosity
- Slag & Inclusions
- Incomplete or lack of fusion
- Lack of penetration

Welding **macrostructures**

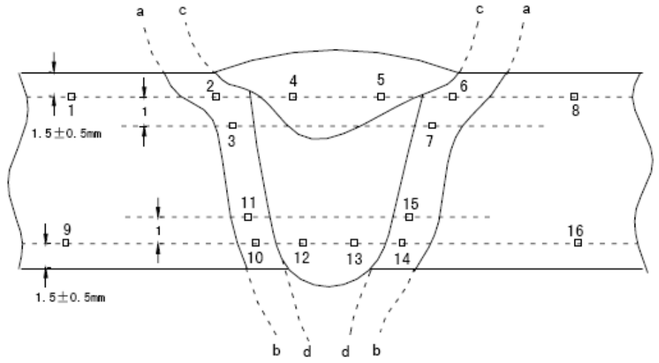


M7 (5'o clock)



M9 (9'o clock)

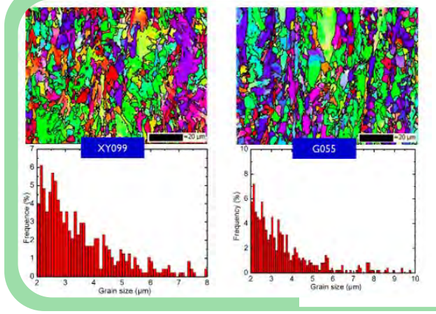
MICRO HARDNESS
MAPS



Sample		Location (HV_{10})							
		1(9)	2(10)	3(11)	4(12)	5(13)	6(14)	7(15)	8(16)
		BM	HAZ		WM		HAZ		BM
	E	248	237	220	251	263	243	242	241
	I	227	273	245	246	250	268	217	237
GB/T 31032-2014		OK							

The IWTC has a close technical relationship with the University of Wollongong (UoW), Australia, where CBMM sponsors a number of key pipeline research projects to support the strategic goals of the international pipeline industry. The University has an advanced center setup to implement state-of-the-art equipment, procedures and mechanization for all fabrication **methods related to industrially focused applied research as well as fundamental studies in steel joining technology.**

MICROSTRUCTURES:
OPTICAL AND BY EBSD



EBSD with grain size distribution of different pipe steels.

MECHANICAL TESTS

Tensile strength

Sample No.	b (mm)	a (mm)	Maximum Load (kN)	Rm (MPa)	Fracture Location
A067-T1	25	20	402.2	716	BM
A067-T2			398.1	707	BM
C079-T1			379.2	674	BM
C079-T2			376.2	688	BM
M085-T1			361.0	752	BM
M085-T2			366.5	757	BM
GB/T 31032-2014, Specified requirement			-	≥ 625	BM

A067 C079 M085

GB/T 31032-2014 **only requires the Rm for rectangular** plate tensile samples is higher than 625 MPa

Bending

A067

No.	Sample LXWXT,mm	Diameter of bent axle/mm	Angle of bending °	Bending direction	Results	Assessment
S1-1	300 X 13 X 21.4	90	180	Side	No crack	OK
S1-2	300 X 13 X 21.4	90	180	Side	No crack	OK
S2-1	300 X 13 X 21.4	90	180	Side	No crack	OK
S2-2	300 X 13 X 21.4	90	180	Side	No crack	OK

C079

S1-1	300 X 13 X 21.4	90	180	Side	No crack	OK
S1-2	300 X 13 X 21.4	90	180	Side	No crack	OK
S2-1	300 X 13 X 21.4	90	180	Side	No crack	OK
S2-2	300 X 13 X 21.4	90	180	Side	No crack	OK

M085

S1-1	300 X 13 X 18.4	90	180	Side	2X1X1mm	OK
S1-2	300 X 13 X 18.4	90	180	Side	1X0.5X0.5mm	OK

Nick break

C079

No.	Sample Direction	LXWXT,mm	Results		Assessment
N1	Vertical to WM	300 X 25 X 21.4	No defects		OK
N2	Vertical to WM	300 X 25 X 21.4	No defects		OK

M085

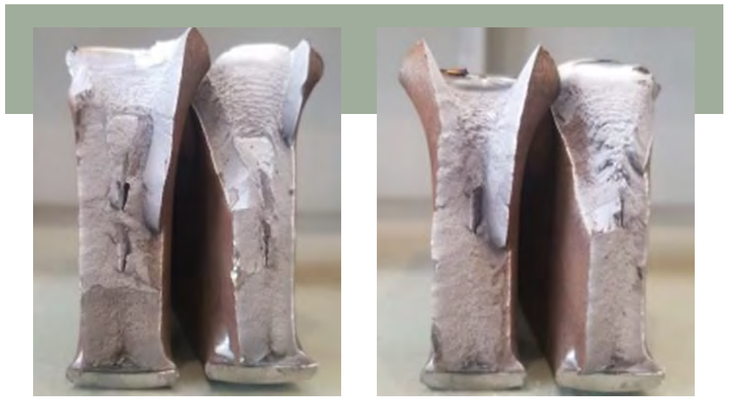
N1	Vertical to WM	300 X 25 X 21.4	No defects		OK
N2	Vertical to WM	300 X 25 X 21.4	No defects		OK

DWTT

DWTT for base metal of different steels

Sample No.	SA/% (-5°C)	
	Single	Average
G055-SAWL	90	88
	86	
A067-SAWH	100	100
	100	
F071-SAWL	88	90
	91	
C079-SAWH	95	97
	99	
M085-SAWH	100	100
	100	

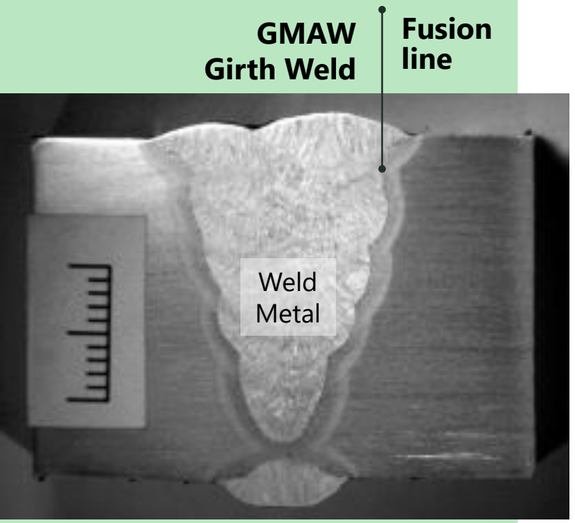
Sampling location: 90°, Transverse
Individual, 70% SA / Average 85% SA (-5°C)

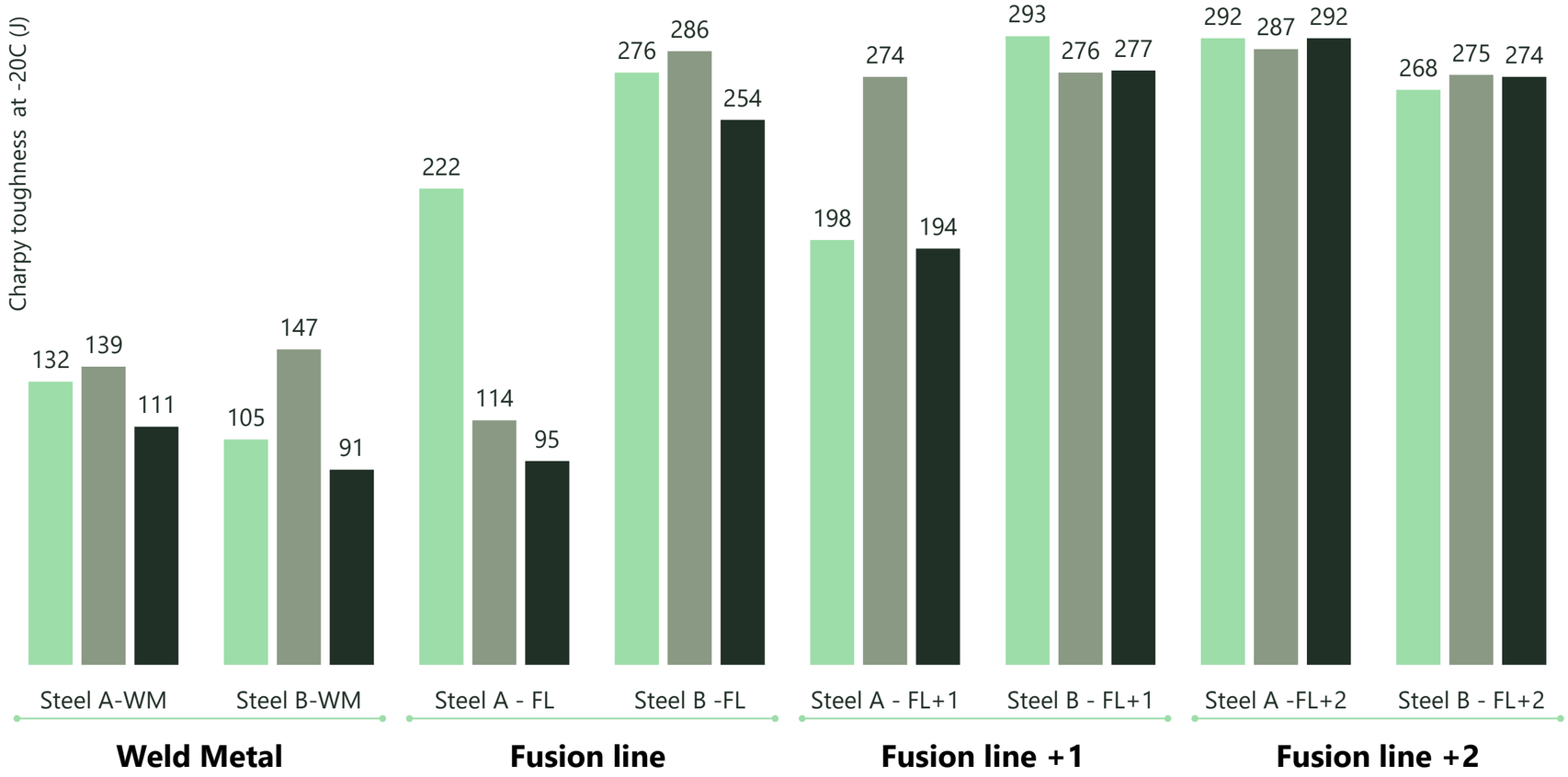


CHARPY TESTS

For different regions
of weld metal and HAZ

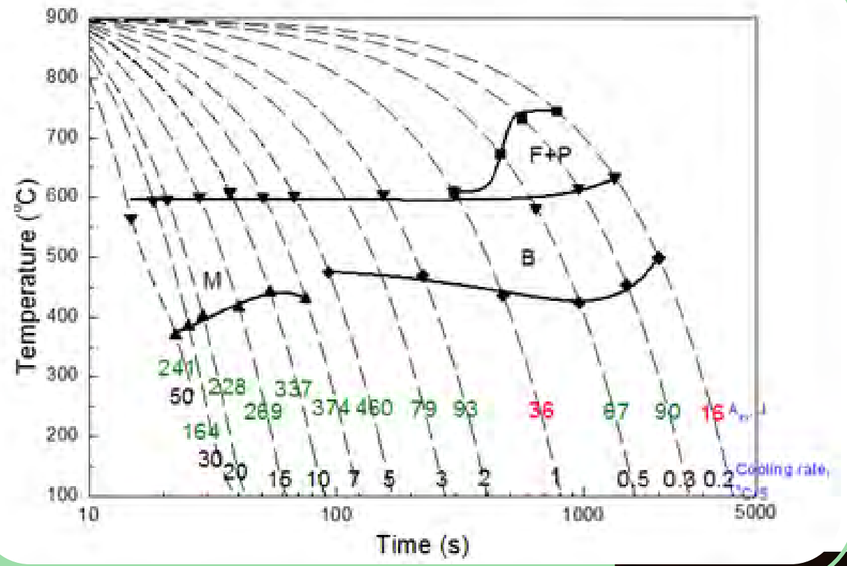
Charpy tests of Girth Welds of different pipes:
Weld Metal and HAZ for Steel A and Steel B

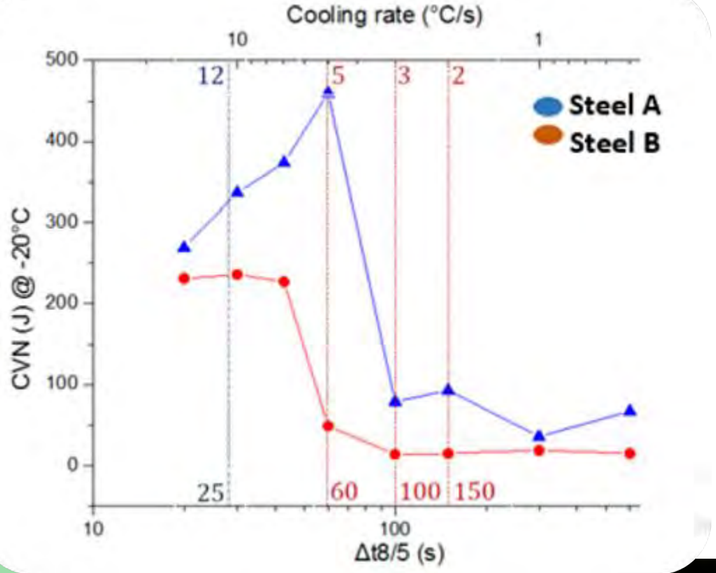




CCT Curves and Charpy tests for all

COOLING RATES





Effect of the cooling rate of the CCT curves on the Charpy toughness of different steels

IWTC can provide the complete definition of the welding process for every pipe design.

It can simulate and make real girth welds considering the dimensions of the pipelines and all parameters to be used during implementation in the field.

The welder can be trained at IWTC, to clearly understand the process, reducing the potential for mistakes in the field.

Any different steel alloy design, consumable or welding process can be tested at the laboratory, answering in advance any concerns for each item.

CBMM | Niobium Nb

World leader in the production and commercialization of Niobium products, CBMM has customers in over 40 countries. With headquarters in Brazil and offices and subsidiaries in China, Netherlands, Singapore, Switzerland and the United States, the company supplies products and cutting–edge technology to the infrastructure, mobility, aerospace and energy sectors. CBMM was founded in 1955 in Araxá, Minas Gerais, and relies on a strong technology program to increase Niobium applications, growing and diversifying this market.

Further information can be obtained at ***www.niobium.tech***