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### Green manufacture – General technology specifications of water-cooled metal mold centrifugal casting machine for ductile iron pipe

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## Forward

China Foundry Association(CFA) is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This document is drafted in accordance with the rules given in the GB/T 1.1-2020 *Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents*.

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## Introduction

The experience in the design, manufacture and application of more than 300 sets of water-cooled metal mold centrifugal casting machine in China for more than 30 years are summarized in this document, and it is the first time to establish the “Green manufacture - General technology specifications of water-cooled metal mold centrifugal casting machine for ductile iron pipe”.

The implementation of this document will promote the technical level of all casting pipe equipment and improve the management level of enterprises,It has pioneering significance in implement of industrial base and intelligent manufacture, standardization of green manufacture and quality, and promotes the international competitiveness of the industry of centrifugal casting machine.

For equipment manufacturers, implementing unified standards is expected to achieve orderly competition in quality and performance, obtain reasonable economic benefits, and enhance the development of the enterprise.

# Green manufacture – General technology specifications of water-cooled metal mold centrifugal casting machine for ductile iron pipe

## 1 Scope

This document specifies the terms, classification, basic parameters, technical requirements, test methods, inspection rules and marks, packaging, transport and storage of the water-cooled metal mold centrifugal casting machine(WCCM).

This document is applicable to the design, manufacture and inspection of WCCM for DN80 to DN1200 ductile iron pipe(DIP) as defined in GB/T 13295(ISO 2531) and GB/T 26081.

## 2 Normative references

The following normative documents contain contents which, through reference in this text, constitute indispensable provisions of this document. For dated references, only the edition corresponding to this date applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- GB/T 230.1, *Metallic materials - Rockwell hardness test - Part 1: Test method*(ISO 6508-1, MOD)
- GB/T 231.1, *Metallic materials - Brinell hardness test - Part 1: Test method*(ISO 6506-1, MOD)
- GB/T 699, *Quality carbon structural steels*
- GB/T 700-2006, *Carbon structural steels*(ISO 630:1995, NEQ)
- GB/T 1184, *Geometrical tolerancing - Geometrical tolerance for features without individual tolerance indications*(ISO 2768-2:1989, EQV)
- GB/T 1576, *Water quality for industrial boilers*
- GB/T 1804, *General tolerances - Tolerances for linear and angular dimensions without individual tolerance indications*(ISO 2768-1:1989, EQV)
- GB 2585, *Hot-rolled steel rails for railway*
- GB/T 2893.1, *Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings*(ISO 3864-1:2011, MOD)
- GB/T 3077, *Alloy structural steels*
- GB/T 3766, *Hydraulic fluid power - General rules and safety requirements for systems and their components*(ISO 4413:2010, MOD)
- GB 4053 *Safety requirements for fixed steel ladders and platform - Part 3: Industrial guardrails and steel platform*
- GB 5083, *General rules for designing the production facilities in accordance with safety and health requirements*
- GB/T 5117, *Covered electrodes for manual metal arc welding of non-alloy and fine grain steels*(ISO 2560:2009, MOD)
- GB/T 5226.1, *Electrical safety of machinery - Electrical equipment of machines - Part 1: General*

*requirements*(IEC 60204-1:2016, IDT)

GB/T 6576, *Machine tools - Lubrication systems*(ISO 5170:1977, MOD)

GB 7251.1, *Low-voltage switchgear and controlgear assemblies - Part 1: General rules*(IEC 61439-1:2011, IDT)

GB 7251.2, *Low-voltage switchgear and controlgear assemblies - Part 2: Particular requirements for busbar trunking systems(busways)*(IEC 60439-2:2000, IDT)

GB/T 7251.3, *Low-voltage switchgear and controlgear assemblies - Part 3: Particular requirements for low-voltage switchgear and control gear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards*(IEC 60439-3:2012, IDT)

GB/T 7932, *Pneumatic fluid power - General rules and safety requirements for systems and their components*(ISO 4414:2010, IDT)

GB 8959, *Dust control code for foundry*

GB 8978, *Integrated wastewater discharge standard*

GB/T 9239.1, *Mechanical vibration - Balance quality requirements for rotors in a constant(rigid) state - Part 1: Specification and verification of balance tolerances*(ISO 1940 - 1:2003, IDT)

GB/T 9969, *General principles for preparation of instructions for use of industrial products*

GB 12348, *Emission standard for industrial enterprises noise at boundary*

GB/T 13306, *Plates*

GB/T 15706.1, *Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology*(ISO 12100-1:2003, IDT)

GB/T 15706.2, *Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles*(ISO 12100-2:2003, IDT)

GB/T 16754, *Safety of machinery - Emergency stop function - Principles for design*(ISO 13850:2015, IDT)

GB/T 16855.1, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design*(ISO 13849-1:2015, IDT)

GB/T 17248.3, *Acoustics - Noise emitted by machinery and equipment - Measurement of emission sound pressure levels at work station and at other specified positions - Survey method in situ*(ISO 11202:1995, EQV)

GB 18599, *Standard for pollution control on the non-hazardous industrial solid waste storage and landfill*

GB 18613, *Minimum allowable values of energy efficiency and values of efficiency grades for motors*

GB 20905, *Safety requirements for foundry machinery*

GB/T 25711, *Foundry machinery - General technical requirements*

GB/T 31552, *Foundry machinery - Model formulating means*

GB/T 37400.1, *Heavy mechanical general technical specification - Part 1: Products inspection and test*

GB/T 37400.3, *Heavy mechanical general technical specification - Part 3: Welding parts*

GB/T 37400.4, *Heavy mechanical general technical specification - Part 4: Iron castings*

GB/T 37400.5, *Heavy mechanical general technical specification - Part 5: Nonferrous metal castings*

GB/T 37400.6, *Heavy mechanical general technical specification - Part 6: Steel Castings*

GB/T 37400.8, *Heavy mechanical general technical specification - Part 8: Forgings*

GB/T 37400.9, *Heavy mechanical general technical specification - Part 9: Machining Parts*

GB/T 37400.10, *Heavy mechanical general technical specification - Part 10: Assembling*

GB/T 37400.11, *Heavy mechanical general technical specification - Part 11: Piping*

GB/T 37400.12, *Heavy mechanical general technical specification - Part 12: Painting*

GB/T 37400.13, *Heavy mechanical general technical specification - Part 13: Packaging*

GB/T 37400.16, *Heavy mechanical general technical specification - Part 16: Hydraulic System*

- GB/T 37683, *Large gear and girth gear forgings - Technical specification*  
 GB/T 37775, *Heavy steel open die forgings - General technical specification*  
 GB/T 38275, *Lubrication system - Inspection specification*  
 GB 39726, *Emission standard of air pollutants for foundry industry*  
 GB 50017, *Standard for design of steel structures*  
 GB/T 50054, *Code for design of low voltage electrical installations*  
 GB/T 50055, *Code for design of electric distribution of general purpose utilization equipment*  
 GB/T 50062, *Code for design of relaying protection and automatic device of electric power installations*  
 GB 50093, *Code for construction and quality acceptance of automation instrumentation engineering*  
 GB/T 50102, *Code for design of cooling for industrial recirculating water*  
 GB 50171, *Code for construction and acceptance of switchboard outfit complete cubicle and secondary circuit electric equipment installation engineering*  
 GB 50231, *General code for construction and acceptance of mechanical equipment installation engineering*  
 GB/T 50254, *Code for construction and acceptance of low - voltage apparatus electric equipment installation engineering*  
 GB/T 50387, *Code for engineering installation acceptance of metallurgical machinery hydromatic, lubricating and pneumatic system equipment*  
 JB/T 7943.1, *General specification for lubrication systems and elements*  
 JB/T 7943.2, *Recommendation for inspection of lubrication system and elements*  
 YB/T 5055, *Crane rails*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply, see Figure A.2.1 and Figure A.2.2.

#### 3.1

##### **Water-cooled metal mold centrifugal casting machine (WCCM)**

Centrifugal casting machine adopting the moisture-free coating and metal mold cooled by water (including water jacket or water jets)

Note 1 to entry: It consists of main centrifugal casting system, pouring system, extraction system, receiving device, conveying device, protective hood, water cooling system, hydraulic system, electrical control system, sewage collecting system, dust collection system and solid waste collecting system, etc.

#### 3.2

##### **Main centrifugal casting system**

System making molten iron forming pipe inside the mold under centrifugal force generated by high speed spinning

Note 1 to entry: It consists of mold driving device, mold support device, core loading device and bogie.

#### 3.3

##### **Mold driving device**

Mechanism driving the mold support device to spin

Note 1 to entry: It consists of main driving motor, motor base, and belt tension mechanism, etc.

#### 3.4

##### **Mold support device (also called machine head)**

Device fixing mold socket by inner ring, installed on flange of bogie socket

3.5

Core loading (setting) device

Device placing the sand core into socket of mold for fixing and compacting, spinning with mold

Note 1 to entry: It consists of swing mechanism, compacting mechanism, and sand core support frame (also called core bracket or core wheel).

3.6

Bogie

Main body of the WCCM

Note 1 to entry: It consists of housing, trolley and driving device, water cooling pipeline, top and bottom rollers, v-shaped support roller and spigot sealing device, etc.

3.7

Pouring machine base

Framework supporting the pouring machine

3.8

Hopper tilting mechanism

Mechanism overturning hopper around its axis

3.9

Fall chute

Device leading molten iron from hopper to trough

3.10

Trough interchanging device

Device shifting the trough to achieve interchanging

3.11

Trough (runner)

Device leading molten iron from fall chute to spinning mold

3.12

Trough tilting device

Device overturning the trough, installed on trough interchanging device

3.13

Inoculant device

Device supplying inoculant to molten iron in trough

3.14

Mold powder device

Device supplying mold powder into mold

3.15

Extraction system

System extracting the solidified pipe out of the mold

Note 1 to entry: It consists of extracting trolley, driving device, and rotating extractor head, etc.

3.16

Receiving device

Device carrying the extracted pipe to conveying device

3.17

Conveying device



Device transporting pipes

3.18

Pipe lifting device

Device transferring pipes from elevated platform to bottom platform

3.19

Solid waste collection system

Device collecting and transporting the solid waste

4 Classification and basic parameters

4.1 Classification

4.1.1 According to the mold cooling type, WCCM can be classified as: water jacket type, water jets type.

4.1.2 According to the driving type of bogie, WCCM can be classified as: electric type, hydraulic type.

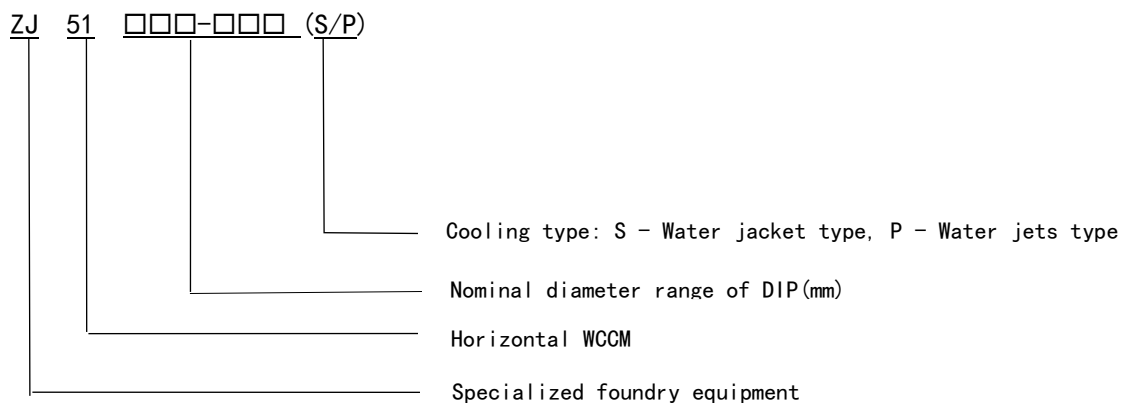
4.1.3 According to the extraction type, WCCM can be classified as: full length extraction, partial length extraction.

Note: The driving type of pouring system and extraction system can be agreed by user and supplier.

4.2 Model

The model of WCCM shall be given as specified in GB/T 31552, see Figure 1.

4.2.1 Model and typical example



Note: □ shall be in digits. The pipe length can be agreed by supplier and user.

Figure 1 Legend of model of WCCM

4.2.2 Example of model

Model: ZJ 51 80-300 S, that means it is a horizontal WCCM, the range of DIP size is from DN80 to DN300, water jacket cooling type.

4.2.3 Typical model

The typical model of WCCM are shown in Table 1.

Table 1 Typical model of WCCM

Typical model	DIP size	Mould cooling method
ZJ51 80-300S	DN80-DN300	Water jacket
ZJ51 300-600P	DN300-DN600	Water jets
ZJ51 700-1000P	DN700-DN1000	Water jets
ZJ51 800-1200P	DN800-DN1200	Water jets
Note: Other model can be agreed by supplier and user.		

### 4.3 Basic parameters

4.3.1 The basic parameters of the WCCM are shown in Table 2.

Table 2 Basic parameters of WCCM

Typical model	Number of machine heads (set)	Mold Speed (rpm)	Power of mold motor (kW)	Effective stroke of bogie (m)	Traversing speed of bogie (m/min)	Number of bottom and top rollers (Group)	Speed of extracting trolley (m/min)	Total weight * (approx ton)
ZJ51 80-300S	3	≤1200	≤160	≥6.3	≤65	4	≤75	90
ZJ51 300-600P	2	≤500	≤250	≥6.3	≤55	2	≤65	105
ZJ51 700-1000P	1	≤350	≤300	≥6.3	≤50	1	≤55	140
ZJ51 800-1200P	2	≤300	≤350	≥6.35	≤45	1	≤50	145

\* The parameters in this table is based on full length extracting WCCM.

Note:

1. The power of complete machine shall be specified by supplier. If there are any special requirements, they can be agreed by supplier and user.

2. The values in this table are based on DIP that effective length is 6 meters as a reference.

### 4.3.2 Cooling water for mold

4.3.2.1 The parameters of cooling water for mold are shown in Table 3.

Table 3 Flow rate of WCCM cooling water

WCCM model	Inlet temperature (°C)	Inlet pressure (MPa)	DIP size	Flow rate of circulating water (m <sup>3</sup> /h)
ZJ51 80-300S	≤35	≤1.0	DN80 - DN300	95 - 140
ZJ51 300-600P			DN350 - DN600	150 - 260
ZJ51 700-1000P			DN700 - DN1000	280 - 390

ZJ51 800-1200P			DN800 - DN1200	290 - 420
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#### 4.3.3 Cooling water quality requirements

The water quality shall meet following requirements:

- a) suspended substance shall be less than 20 mg/L,
- b) water hardness shall not be more than 3 mg/L,
- c) pH value shall be 7 to 8,
- d) at the cooling water inlet, the temperature shall not be more than 35°C, the pressure shall not be more than 1.0 MPa. Softened water that meets the requirements of GB/T 1576 should be selected.

### 5 Technical requirements

#### 5.1 General

In addition to comply with this document, the design and manufacture of WCCM shall be as specified in GB/T 25711 also.

#### 5.2 Environment conditions of operation

##### 5.2.1 Climate and environment

5.2.1.1 Environment temperature for operation: -5 °C to +40 °C. If operation temperature is beyond this temperature range, the measures for cold-proof or cooling shall be taken according to different regions.

5.2.1.2 The relative humidity shall not exceed 50% at temperature of +40°C.

5.2.1.3 Altitude shall not be higher than 1000 meters.

Note: If altitude is beyond this range, it shall be discussed by user and supplier.

##### 5.2.2 Work location

In sheltered place.

#### 5.3 Principle requirements

5.3.1 The WCCM shall be in accordance with requirements in this document, and manufactured according to approved drawings and technical documents.

5.3.2 Steel structures shall be designed as specified in GB 50017.

5.3.3 The safety and sanitation shall be designed as specified in GB 5083.

5.3.4 The dimensional, geometrical, positional and unspecified tolerance in design drawings shall be as specified in GB/T 1804 and GB/T 1184.

5.3.5 Appearance requirements of the WCCM shall be in accordance with GB/T 25711-2010, Clause 5, and there shall be no defects such as bulge, sunk, rough, bumps, scratches, and rust, etc which are not specified in drawings.

5.3.6 Raw materials and purchased parts shall be as specified in this document and related standards, quality certificates of them shall be provided.

5.3.7 Machining parts shall be as specified in GB/T 37400.9 and GB/T 37400.1.

5.3.8 Welding parts shall be as specified in GB/T 37400.3 and GB/T 37400.1.

5.3.9 Iron castings shall be as specified in GB/T 37400.4 and GB/T 37400.1.

5.3.10 Non-ferrous castings shall be as specified in GB/T 37400.5 and GB/T 37400.1.

- 5.3.11 Steel castings shall be as specified in GB/T 37400.6 and GB/T 37400.1.
- 5.3.12 Forgings for general purposes shall be as specified in GB/T 37400.8 and GB/T 37400.1. Large steel parts by free forging, forgings of large gears and tooth rings, etc shall be as specified in GB/T 37775, GB/T 37683.
- 5.3.13 Pipelines of the WCCM shall be as specified in GB/T 37400.11 and GB/T 37400.1.
- 5.3.14 The lubrication system shall be designed and manufactured as specified in JB/T 7943.1 and JB/T 7943.2. The inspection of the lubrication system shall be conducted as specified in GB/T 38275 and GB/T 50387.
- 5.3.15 The circulation system of mold cooling water shall be designed and manufactured as specified in GB/T 50102.
- 5.3.16 The pneumatic system shall be designed and manufactured as specified in GB/T 7932.

5.4 Design productivity

The design productivity of WCCM is shown in Table 4.

Table 4 Design productivity of WCCM

DIP size (DN)	80	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1100	1200
Design productivity (pipes/hour)	85	85	80	75	70	65	60	50	50	45	36	29	25	20	16	14	12

Note 1: The data in this table are based on DIP as defined in GB/T 13295-2019 that manufactured by full length extraction WCCM, the effective length of pipe is 6 meters.  
 Note 2: The design and actual productivity of the partial length extraction WCCM shall be agreed by user and supplier.

5.5 Safety and protection

- 5.5.1 The safety protection of the WCCM shall be as specified in GB 20905.
- 5.5.2 The parts which will collide or squeeze the operator easily (such as the both ends of the bogie) shall be painted with stripes with alternate colour of yellow and black as specified in GB/T 2893.1.
- 5.5.3 There shall be reliable electrical interlocks during movement of each mechanism. Under the condition of correct parameters inputted, if wrong operation or programming, there shall not be any action interference and mechanical damage.
- 5.5.4 Safety requirements of toxic gas, smoke, dust and heat hazard shall be as specified in GB 20905.
- 5.5.5 Interlock or self-lock protection shall be used at the position where mechanical collision and other hazards may occur during movement.
- 5.5.6 Parameters related safety in the system shall be set to make them cannot be changed by user.
- 5.5.7 Stairs, operating platforms and guard rails shall be as specified in GB 4053.3.

5.6 Materials selection

5.6.1 Materials for main centrifugal system

- 5.6.1.1 The material performance of bogie frame shall meet design requirements and be as specified in GB/T 700-2006. The welding rods, wires and flux shall be suitable to material to be welded, welding rods shall be as specified in GB/T 5117.

5.6.1.2 The material performance of shafts shall meet design requirements and be as specified in GB/T 699-2015 or GB/T 3077-2015, the hardness shall be 217 HBW to 255 HBW.

5.6.1.3 The material performance of gears and racks shall meet design requirements and be as specified in GB/T 3077-2015. The working surface hardness shall be 45 HRC to 50 HRC.

5.6.1.4 The material performance of reducer housing and pulley shall meet design requirements and be as specified in GB/T 37400.4-2019.

5.6.1.5 The material performance of wheels shall meet design requirements and be as specified in GB/T 37400.6-2019. The hardness of wheel tread shall be 45 HRC to 50 HRC, tread hardening depth shall not be less than 4 mm.

5.6.1.6 Rails shall be as specified in GB 2585 or YB/T 5055.

#### 5.6.2 Materials for pouring system

5.6.2.1 The material performance of all shafts shall meet design requirements and be as specified in GB/T 699-2015 or GB/T 3077-2015. After heat treatment, the hardness shall be 217 HBW to 255 HBW.

5.6.2.2 The hardness of rails for trough interchanging device shall be 45 HRC to 50 HRC.

5.6.2.3 The surface hardness of wheels for trough interchanging device shall be 42 HRC to 48 HRC after heat treatment.

5.6.2.4 The material performance for gears shall meet design requirements and be as specified in GB/T 3077. After heat treatment, the hardness of teeth surface shall be 45 HRC to 50 HRC.

5.6.2.5 The material of troughs shall ensure sufficient strength and anti-deformation to withstand rush of molten iron, and the strength shall be as specified in GB/T 3077.

5.6.2.6 The material of fall chutes which will contact with molten iron directly shall ensure sufficient strength and anti-deformation, to withstand rush of molten iron.

#### 5.6.3 Materials for extraction system

5.6.3.1 The material performance of all shafts for extraction system shall meet design requirements and be as specified in GB/T 699-2015 or GB/T 3077-2015, and the hardness shall be 217 HBW to 255 HBW.

5.6.3.2 The working surface hardness of wheels shall be 45 HRC to 50 HRC.

5.6.3.3 Rails shall be as specified in GB 2585 or YB/T 5055.

5.6.3.4 The hardness of pegs on the extracting jaws shall be 60 HRC to 65 HRC.

#### 5.6.4 Materials for receiving system

The working surface hardness of support rollers(rollers) shall be maintained 217 HBW to 255 HBW at 600 °C.

#### 5.6.5 Materials for conveying device

The working surface hardness of support rollers(rollers) shall be not lower than 217 HBW to 255 HBW at 600 °C.

#### 5.7 Accuracy of the main components

The machining accuracy of WCCM main components shall meet the requirements in Table 5.

Table 5 Geometrical tolerance of WCCM main components

System device	Components	Characteristics	ZJ51 80-300S	ZJ51 300-600P	ZJ51 700-1000P	ZJ51 800-1200P
			Tolerance (mm)			

Bogie	Flanges at both ends	Coaxiality	0.1	0.12	0.14	0.15
		Parallelism	0.5	0.5	0.5	0.5
	Wheel axis and center line of bogie	Perpendicularity	0.1	0.15	0.2	0.2
	Center lines of bottom roller base hole and bogie	Symmetry	0.08	0.1	0.12	0.15
	Bottom and top rollers	Radial circular run-out	0.03	0.035	0.038	0.04
	Rail	Straightness and flatness	≤ 0.15/1000			
Pouring system	Trunnion hole for tilting on base	Coaxiality	≤ 0.12			
	Shape of hopper	Dimensional allowance	≤ 5			
	Rail	Straightness and flatness	≤ 0.15/1000			
Extraction system	Mounting surface of trolley wheel	Flatness	≤ 0.2			
	Rail	Straightness and flatness	≤ 0.15/1000			

## 5.8 Assembly and installation

5.8.1 The assembly of WCCM shall be as specified in GB/T 25711 and GB/T 37400.10.

5.8.2 The main mating faces of the WCCM shall contact tightly, and the inserting depth of 0.10mm feeler shall not exceed 1/4 of the section plane width, and the maximum shall not exceed 30 mm. The total sum of inserting length shall not exceed 10% of the outer edge circumference of section plane.

5.8.3 The assembly accuracy of WCCM shall meet the following requirements:

- a) During hopper tilting, interference between the geometrical profile of hopper and top of the trough is not permissible,
- b) The radial circular run-out of mold socket at machine head is shown in Table 6,

Table 6 Radial circular run-out of socket of mold at machine head

Unit: millimeter

Size of mold	DN80-DN300	DN300-DN600	DN700-DN1000	DN800-DN1200
Radial circular run-out	≤ 0.45	≤ 0.65	≤ 0.9	≤ 0.9

- c) At any point of the rail, the height difference of wheel contacting point shall not be more than 1 mm,
- d) The parallelism between the center lines of mold bottom roller and bogie shall not be more than 0.5 mm,
- e) Good contact shall be kept between the mold bottom roller and mold,
- f) The parallelism between the mating surface of drive device that mounted on bogie base and the top surface

of rail shall not be more than 0.2/1000mm,

g) The dimensional allowance shall be less than or equal between 1 to 2 mm of the reference points of top surface of the trough interchanging device rail and top surface of the bogie rail at spigot side. If for the small size WCCM, lower allowance shall be taken.

5.8.4 The installation accuracy of the WCCM shall be as specified in GB 50231:

a) The installation allowance between the center lines of the pouring system and the bogie shall comply with the design drawings,

b) After installation, the flatness of top surfaces of both rails shall not be more than 0.15/1000 mm, and the allowance shall not be more than 3% between actual angle and design angle of rails,

c) The installation allowance of coaxiality shall be less than or equal to 1 to 2 mm between the center lines of extracting jaw and the bogie. If for the small size WCCM, lower allowance shall be taken.

## 5.9 Hydraulic system

5.9.1 The design, manufacture, installation and acceptance shall be as specified in GB/T 3766, GB/T 37400.16 and GB/T 50387.

5.9.2 Devices to prevent over load and impact shall be set in the system.

5.9.3 Hydraulic pipelines shall be arranged in order, oil leakage shall not be happened.

5.9.4 Emergency devices shall be provided to avoid sliding down caused by load on hydraulic cylinders and pipe holding arms, or overspeed down and crush caused by damage and leakage of pipelines.

## 5.10 Dust collection system

5.10.1 Dust collection system shall be equipped on WCCM, collecting hood connected to dust collection system shall be provided as following locations: hopper area, WCCM socket area, WCCM spigot area and extraction area.

5.10.2 Arrangement of dust collecting ducts shall be reasonable, the designated area shall be covered by collecting hood, the dust collection system shall be designed as specified in GB 8985.

5.10.3 After pollutants are treated by purification system, the emission shall be as specified in GB/T 39726.

## 5.11 Sewage and solid waste collection system

5.11.1 Sewage collection system shall be equipped on WCCM, it will be recycled for use after unified treatment, sewage emission shall be as specified as GB 8978.

5.11.2 Collecting bins and transfer device shall be provided in the area where scrap generated at trough, spigot and deslagging, to keep the site neat and orderly. The used sand cores and slags cannot be recycled, shall be as specified as GB 18599 after collecting, transferring and unified treatment.

## 5.12 Electrical control system

### 5.12.1 Power system

5.12.1.1 The electrical control system shall be as specified in GB/T 5226.1, GB/T 50054, GB/T 50055, GB/T 50524, GB/T 50171, GB/T 15706.1, GB/T 15706.2, GB/T 16754, and GB/T 16855.1.

5.12.1.2 All the motors used shall be as specified in GB/T 5226.1, 14.1 and 14.6. and the matching of motors shall be reasonable, economical and safe. The efficient and energy-saving motors shall be selected, the efficiency of the motors shall be as specified in GB 18613.

5.12.1.3 The distribution panels (or boxes, or cabinets) of the WCCM shall be as specified in GB 7251.1, GB 7251.2, GB/T 7251.3 and GB/T 5226.1. The instruments shall be as specified in GB 50093, and the relay

protection shall be as specified in GB/T 50062, the function of monitoring instruments, master control elements, and indicating elements shall be described accurately and clearly, and codes of internal elements and items shall be marked.

#### 5.12.2 Control system

5.12.2.1 The control system shall be accurate and reliable, and the control functions of the system shall be as specified in GB/T 5226.1.

5.12.2.2 Electronic device suitable for environment of high temperature and dust, etc shall be selected.(including the computers, input/output devices and power supplies, etc)

5.12.2.3 Indicating device or screen that display the main equipment status shall be provided on control desks(consoles), and the functions of parameter storage, curve display, data query, backup and export, etc shall be provided.

5.12.2.4 The output interface for data collecting shall be provided in control system.

#### 5.12.3 Grounding

Equipment shall be grounding separately. Grounding resistance shall not be more than 4 Ω.

#### 5.13 Painting

5.13.1 The rust prevention painting of exposed working surfaces of parts, assemblies, and spares shall be conducted as specified in GB/T 37400.12.

5.13.2 If there are any special requirements, they can be agreed by user and supplier.

#### 5.14 Completeness

5.14.1 The scope of the completeness of WCCM is shown as follows:

- a) Pouring system,
- b) Main centrifugal system,
- c) Extraction system,
- d) Receiving device,
- e) Conveying device,
- f) Weighing device,
- g) Hydraulic system,
- h) Electrical control system,
- i) Dust collection system,
- j) Sewage and solid waste collection system,
- k) The WCCM spares and wearing parts shall ensure performance and interchangeability.

Note: The completeness can be finalized according to the process requirements of user.

5.14.2 The configuration table of WCCM is shown in Annex A, Table A.1.

5.14.3 The technical documents along with equipment shall be as specified in GB/T 9969. The technical documents provided along with the WCCM shall include following at least:

- a) Operation and maintenance manual (including wearing parts list),
- b) Diagram of hydraulic system and electrical system(including critical elements manual),
- c) Packing list,
- d) Quality certificates,
- e) Installation drawings,



f) Other technical documents if necessary.

#### 5.15 No-load trial

5.15.1 The no-load shall be as specified in GB/T 37400.10.

5.15.2 The time of continuous no-load trial shall not be less than 4 hours, malfunctions shall not happen during the process of continuous trial. If any abnormal or malfunction happen, after reasons are found out, and adjustment or troubleshooting will be done, trial shall be restarted.

5.15.3 The action of various working mechanisms, operating mechanisms, and safety protection devices, electrical control system, hydraulic and pneumatic system of WCCM shall be flexible and reliable, they shall coordinate with each other and run smoothly.

5.15.4 There shall not be loosen at all fasteners, connections of pipelines and cables.

5.15.5 There shall not be leakage of oil, air or water in systems of hydraulic, pneumatic, lubricating and cooling.

5.15.6 During no-load trial at rated rotation speed, the level of noise shall be as specified in GB 12348.

5.15.7 During no-load trial, traversing speeds and setting values of WCCM in different driving type are shown as following:

a) Traversing speed of bogie:

1) If driving by hydraulic, the deviation shall not exceed 5 %,

2) If driving by electrical, the deviation shall not exceed 2 %.

b) Pouring system:

1) If driving by hydraulic, the deviation between the angular velocity and the setting value shall not exceed 3 %,

2) If driving by electrical, the deviation shall not exceed 1.5 %.

5.15.8 After 4 hours of continuous no-load trial, inspect the temperature rise and maximum temperature of the main bearings, and results shall not exceed the specifications of Table 7.

Table 7 Temperature limits of main bearings under different trial conditions

Unit: °C

Item		Temperature rise	Maximum temperature
Sliding bearing	No-load trial	≅ 35	≅ 85
Rolling bearing	No-load trial	≅ 20	≅ 70

5.15.9 At the rated working pressure, after the medium reaches thermal equilibrium through continuous running of hydraulic system, inspect temperature and temperature rising, the maximum temperature shall not higher than 60 °C.

5.15.10 The inoculant and mold powder shall be transported evenly to meet the technical requirements.

5.15.11 If there is condition limitation at the manufacturer's plant, the inspection and test may be carried out at the user's plant after user approval.

5.15.12 After above 5.15.1 to 5.15.10 are all met, the continuous load trial, and assessment of average productivity can be negotiated mutually of user and supplier.

#### 6 Test methods

6.1 Measurement of material hardness at any three points on the surface of the part, take the lowest value as the standard. The sample test can be done for hardness at the depth of hardened layer and 4 mm of the part, the

material of sample and the part shall be same, it shall be as specified in GB/T 230.1 and GB/T 231.1.

- 6.2 Appearance quality of welded structure can be inspected by observation method in accordance with GB/T 25711-2010, Clause 5.
- 6.3 Accuracy of parts shall be inspected by regulation measurement as per design drawings, it shall be in accordance with GB/T 1804, GB/T 37400.1 and GB/T 37400.10.
- 6.4 Inspection of assembly and installation shall be conducted as per design drawings, it shall be in accordance with GB/T 25711, GB/T 37400.10 and GB 50231.
- 6.5 Static balance test for mold and support roller shall be conducted as specified in GB/T 9239.1.
- 6.6 Inspection and test of hydraulic system shall be conducted in accordance with GB/T 3766-2015, Subclause 6.
- 6.7 Inspection and test of pneumatic system shall be conducted in accordance with GB/T 7932-2017, Subclause 6.
- 6.8 Inspection and test of lubrication system shall be conducted in accordance with GB/T 38275.
- 6.10 Inspection and test of cooling system shall be conducted in accordance with GB/T 50231.
- 6.11 Painting qualify can be inspected by sample comparison method in accordance with GB/T 37400.1 and GB/T 37400.12.
- 6.12 Temperature measuring of bearings and hydraulic medium can be conducted by thermocouple potentiometer in accordance with requirements given in 5.15.8 and 5.15.9.
- 6.13 Noise test shall be conducted as specified in GB/T 17248.3, it shall be in accordance with requirements given in 5.15.6.
- 6.14 Electrical control system test shall be conducted as specified in GB 5226.1, check the working states of electrical system, connection of all electrical items are fastened, the response of buttons are sensitive.
- 6.15 No load trial shall be inspected in accordance with requirements given in 5.15.1 to 5.15.10.
- 6.16 Dust emission concentration measuring of dust collection system shall be conducted in accordance with provisions of environmental protection department.

## 7 Inspection rules

### 7.1 Summary

Inspection is composed by factory inspection, hot load trial inspection and acceptance inspection.

### 7.2 Factory inspection

- 7.2.1 Each WCCM shall pass the factory inspection that conducted by the technical inspection department of the manufacturer, and the product quality certificate shall be provided along with the WCCM when leave factory.
- 7.2.2 The items of factory inspection shall be carried out as specified in Table 8.
- 7.2.3 All factory inspection items shall be qualified.

Table 8 Test method of WCCM

Serial number	Inspection item	Technical requirement	Inspection method
1	Hardness	5.6.1 - 5.6.5	6.1
2	Accuracy of parts	5.7	6.3

3	Assembly and installation	5.8	6.4
4	Hydraulic system	5.9	6.6
5	Pneumatic system	5.3.1.16	6.7
6	Lubrication system	5.3.1.14	6.8
7	Cooling system	5.3.1.15	6.10
8	Temperature of bearings and hydraulic medium	5.15.8, 5.15.9	6.12
9	Electrical control system	5.12	6.14
10	Painting	5.13	6.11
11	No load trial	5.15	6.15
12	Equipment noise	5.15.6	6.13

### 7.3 Hot load trial and acceptance

7.3.1 After 4 hours of no load trial, the WCCM shall meet the requirements as given in 5.15, hot load trial shall be conducted in accordance with contract of user between supplier.

7.3.2 Acceptance inspection including:

- a) Machine parameters as specified in 4.3.
- b) Contents as specified in 5.15.
- c) Agreed contents in contract of user between supplier.

7.3.3 Dust emission after purification shall be in accordance with requirements given in 5.10.3.

7.3.4 Emission of waste water and solid waste after treatment shall be in accordance with requirements in 5.11.

7.3.5 Process of hot load trial and acceptance terms can be agreed in the contract of user between supplier.

## 8 Marking, packaging, transport and storage

### 8.1 Marks and nameplates

8.1.1 Product nameplate shall be fixed at prominent position on the machine, the type and size of nameplate shall be as specified in GB/T 13306.

8.1.2 The contents on the nameplate shall include:

- a) Product name and model,
- b) Manufacturer name and address,
- c) Serial number, date of manufacture,
- d) Basic parameters.

### 8.2 Packaging

- a) The packaging of WCCM shall be as specified in GB/T 37400.13,
- b) The conveying trolley, rail frame, rails and other large components of the WCCM are allowed to be packaged by bundling, and there shall be code and mark on it.

### 8.3 Transport and Storage

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- a) The drawing for packaging, storage and transport shall be as specified in GB/T 37400.13,
- b) The transport of WCCM shall be in accordance with the provisions of railway, road, waterway transport and mechanized loading.

Annex A  
(informative)  
Configuration table of WCCM

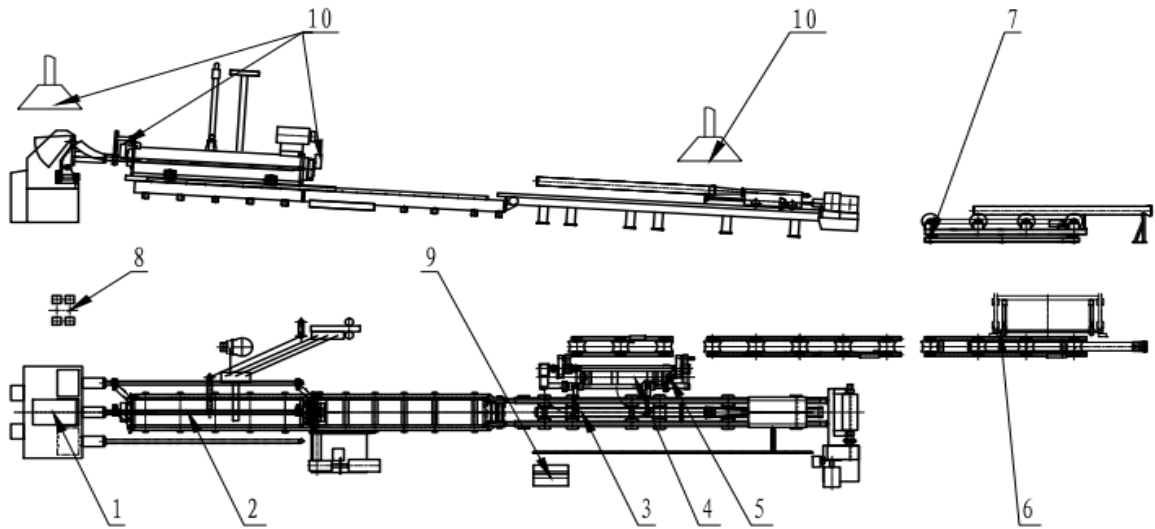
A.1 Configuration of WCCM, see Table A.1.

Table A.1 Configuration table of WCCM

DIP size (DN)			DN80 to DN300	DN350 to DN600	DN700 to DN1000	DN800 to DN1200
Device/system function			Configuration options			
Mold cooling system	Type	1) Water jacket	★	√	√	√
		2) Water jet	√	★	★	★
Pouring system	Hopper tilting by	1) Electrical	★	★	★	★
		2) Hydraulic	√	√	√	√
Main centrifugal casting system	Traversing driven by	1) Electrical	★	★	★	★
		2) Hydraulic	√	√	√	√
	Mold driven by	Electrical	●	●	●	●
Extraction system	Arrangement type	1) Full length	★	★	★	★
		2) Partial length	√	√	√	√
Receiving device	Driven by	1) Swing arm	★	★	√	√
		2) Forklift	√	√	★	★
		3) Rotation arm	√	√	√	√
Conveying device	Driven by	1) Roller	★	★	—	—
		2) Mobile trolley	—	—	★	★
Pipe lifting device	Driven by	1) Electrical	★	★	★	★
		2) Hydraulic	—	—	—	—
Dust collection system	Area to be arranged	hopper, socket, spigot, and extracton system area	●	●	●	●
Hydraulic system	Medium	1) Water glycol*	★	★	★	★
		2) Hydraulic oil	√	√	√	√
Control mode	Mode	Full automatic, semi-automatic, manual	●	●	●	●
Used sand, slag and scrap	Collection method	Hopper, chain belt, belt, forklift	●	●	●	●
Waste water collection	Collection method	Collecting chute, pool	●	●	●	●

\* Applied to the pouring area.  
 Note 1: ● - Required, ★ - Preferred, √ - Optional.  
 Note 2: Other configurations will be agreed by the supplier and user.

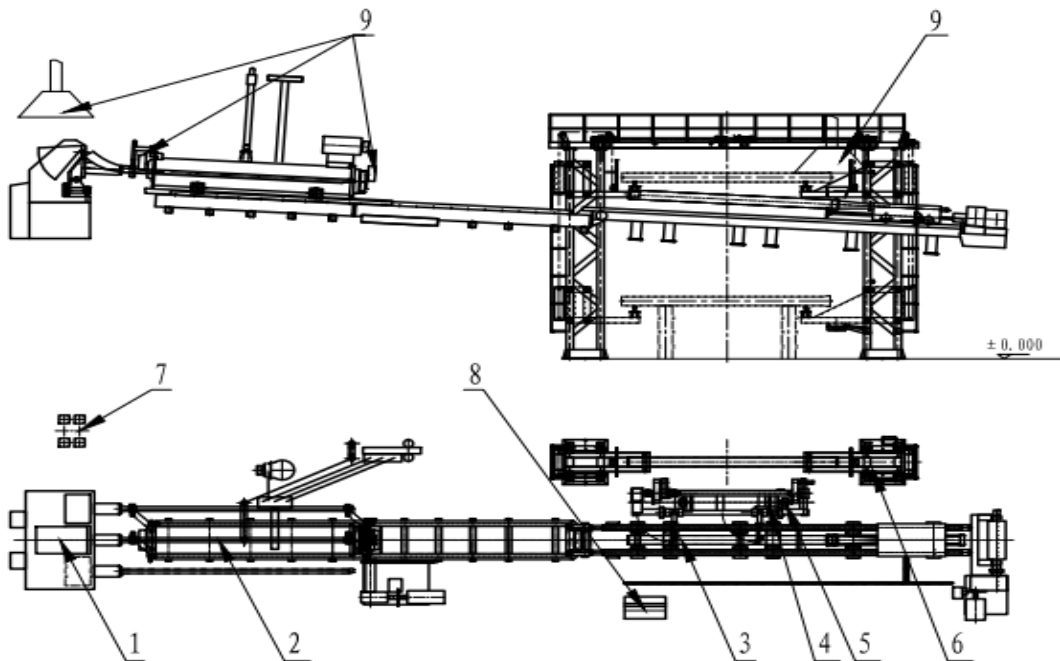
A. 2 Schematic diagram of WCCM is shown in Figure A.2.



- 1. Pouring system
- 2. Bogie
- 3. Extraction system
- 4. Receiving device
- 5. Weighing device
- 6. Pipe turning over machine
- 7. Conveying roller
- 8. Hydraulic system
- 9. Electrical control system
- 10. Dust collection hood

Figure A.2 Schematic diagram of WCCM

A. 3 Schematic diagram of WCCM equipped with pipe lifting device is shown in Figure A.3



- 1. Pouring system
- 2. Bogie
- 3. Extraction system
- 4. Receiving device
- 5. Weighing device
- 6. Pipe lifting device
- 7. Hydraulic system
- 8. Electrical control system
- 9. Dust collection hood

Figure A.3 Schematic diagram of WCCM (equipped with pipe lifting device)