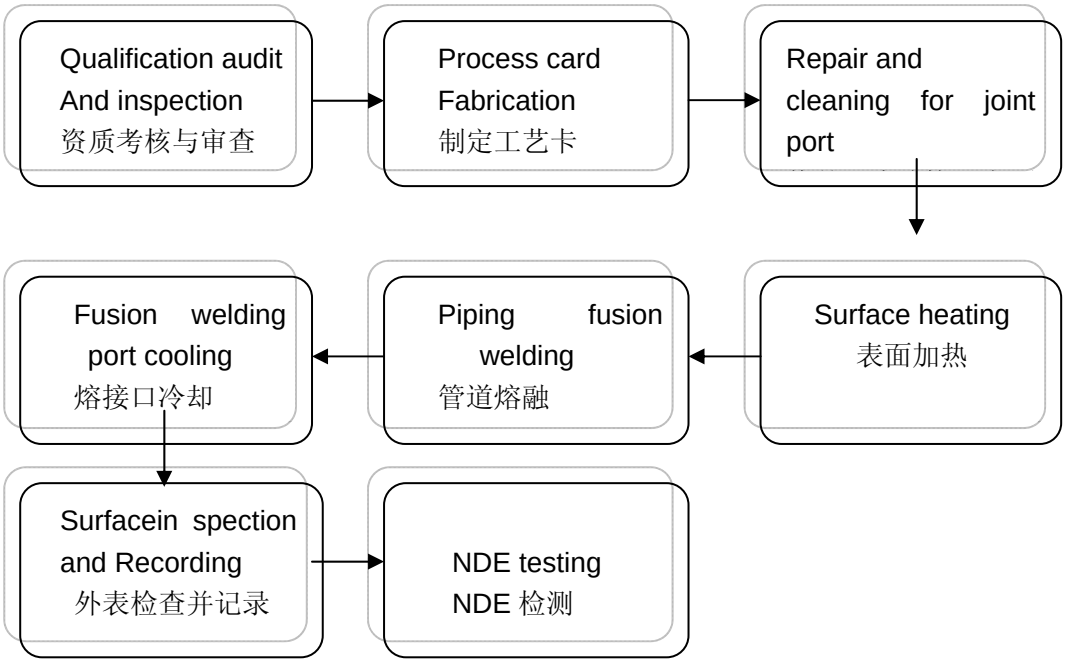
1.1.1 HDPE Piping Fusion Welding Plan and Regulations
HDPE 管道熔接方案及规程

1.1.1.1 HDPE piping fusion welding procedures
HDPE 管道的熔接流程



1.1.1.2 Welding Operation 焊接操作

Heat fusion bonding is a combination of temperature and force resulting in two mating surfaces flowing together to produce a joint. Fusion bonding occurs when the joint cools below the melt temperature of the material. There is a temperature range within which any particular material may be satisfactorily joined. The specified temperature used requires consideration of the properties of the specific material, the fusion equipment being used and the welding environment.

热熔焊接是在两个需连接的表面利用温度和用力挤压的方法将其粘接形成一个接缝。当接缝冷却并低于材料的熔化温度时就形成了热熔连接。对于特殊的材料，会在一个温度范围内产生热熔连接。一种材料的热熔温度应考虑该种材料的特性，使用的热熔及焊接环境。

1.1.1.3 The operations can be summarized as follows: 操作步骤：

The alignment of the pipe 管道找正

The shaving of the surfaces of the pipe ends 修整管端表面

Cold matching of the HDPE pipes 将 HDPE 管对齐

Cleaning of surfaces 清洁管道表面

Heating of surfaces 表面加热

Fusion of surfaces 表面熔融

Cooling of weld joint 焊接接口冷却

1.1.1.4 The parameters used during welding are: 焊接所用到的参数：

pressure (Pressure during heating) in Mpa, 加热压力用 Mpa

Bead-up height in mm, 加热高度用 mm

Heat soaking time (Time of heating under pressure released condition) in seconds,吸热时间(在降压条件下加热的时间)用秒

Heat soaking pressure (Pressure during heating under pressure released condition) in Mpa,吸热压力(在降压条件下的压力)用 Mpa

Transfer time (Switching Time) in seconds, 切换时间用秒

Time of reaching the fusion pressure in seconds, 达到热熔压力的时间用秒

Fusion pressure in Mpa, 热熔压力用 Mpa

Cooling time in minutes.冷却时间用分钟

1.1.1.5 Welding Preparation 焊接准备

The welder and pipe fitter working on HDPE pipe shall be trained by the welding machine manufacturer. The working shall be done after the PMC qualification inspection.
参加 HDPE 管道安装施工的焊工和管工都必须经管道生产厂或焊机生产厂的培训。经管理方考核合格后方可持证上岗。

This is to ensure, whether the welding machine operation condition will satisfy the welding requirement. For example, check whether there is any fastener for holder is missing or loose. Check whether the electrical connection is correct/ working, the oil in hydraulic cylinder is enough, the power supply is matching with the machine requirement, the heating plate match the visual inspection requirement (whether the coating of plate damaged) and perform trial run testing for the shaver and oil pump.
焊接准备工作是确保焊机的工作条件满足焊接要求。检查事项包括：检查是否有卡具未紧固。检查电气连接是否正确，液压筒里的油够不够，电源供电是否符合焊机要求，加热板是否符合外观检查的要求(加热板的涂层是否有损坏)，对铣刀和油泵进行试运行。

After checking the welding machine operation condition, fix the correct size holder on the machine to match with the outer diameter of the pipe to be welded. Set the temperature of the heating plate on thermostat. Use soft paper or cloth and dip on alcohol to clean the heating plate surface. Pay attention to avoid damage of PTFE adhesive prevention layer.
检查完焊机的操作条件后，在焊机上固定和需焊接的管道外径相匹配的夹具。在温度调节器上设定加热板的温度。用柔软的纸或布浸泡酒精后清洗加热板表面。注意不能损坏 PTFE 防粘接层。

1.1.1.6 管道焊接

A Setting of HDPE Piping Component for Welding 放置 HDPE 管

The pipes must be aligned when they are clamped into the welding machine in such

a way that the surfaces are in the same plane (parallel) to each other. The HDPE pipes can be positioned directly into the welding machine. Install correct adapter insert for the size of pipe diameter to be used and tighten them to the machine.当管道放入焊机固定时必须进行找正以使其表面都在同一平面上(平行)。HDPE 管可直接入焊机。装入和管道尺寸相匹配的适配器并固定。

Position the pipe in a way that approx. 20 ~ 50mm is protruding behind the last clamp. By doing this, we will have approx. 5 to 15 mm to shave from, and the remaining 15 to 35 mm should be sufficient for welding.固定管道时，管子应伸出最后一个卡具约 20~50mm，这样，有约 5~15mm 可以铣削，剩余的 15~35mm 用于焊接。

Once the pipe has been placed in position, the top clamps can be closed. It is important to tighten the top clamp nuts evenly in order to get a totally circular pipe. Then, make the first cold matching (press the two pipes to each other)and check the amount of shaving that will be required.管子就位后，顶端的卡具就可以固定了。重要的是将顶部卡具的螺栓均匀地上紧以保证管子不变形。然后，进行第一次冷对口(将两段管子合拢并加以适当的压力)并检查需铣削的厚度。

B Shaving of Surface 铣削管子表面

After the cold matching is completed, open up the pipes and introduce the shaver. Turn the shaver on and adjust to suitable speed.
冷对口结束后，放开管子，置入铣刀，打开铣刀电源形状并调节到适当的速度。

Press the two pipes together, and shave until a continuous strip of HDPE is peeling off on both sides of the shaver.
再合拢管材两端，并加以适当的压力，直到两端均有连续的切屑出现。

The thickness of the cut-off material shall be 0.5 ~ 1.0 mm. The thickness can be adjusted by adjusting the height of the cutter and hydraulic jig.
切屑厚度应为 0.5mm 左右。切屑厚度可通过调节铣刀片和液压夹具的高度来进行调整。

Once constant peeling off is observed, release the pressure on the pipes and separate the pipes. Do not turn off the shaver until the pipes are apart. If the shaver is stopped during shaving, the shaver will create an end cut-mark and the shaving operation will have to be repeated.
出现连续切屑后，撤掉压力并分开管子。管子分开后才能关闭铣刀电源。如果在铣削过程中关闭铣刀，管端上会出现切痕，并且该管段需重新铣削。

Remove the shaver, match the pipes again, and check the pipe for proper alignment.
取出铣刀，再次合拢两管，检查两端的对齐情况。

Sometimes, even when continuous peeling off is achieved on each side of the shaver, the pipes do not match properly. This is normally due to the clamps, which are pressing on to the pipe with different pressures.
有时，即使在铣刀两端有连续的切屑出现，管子还是会出现不能对齐的现象，这是因为在固定管子时夹具施加在管子上压力不同造成的。

Re-tightening the nuts slightly on either side is one solution. But, if this does not help, Only with machine manufacturer's approval.
一种解决办法是重新略微紧固两端的螺帽，但是，如果这样还是不行，经厂家批准用加薄垫片来找正。

Open up one clamp and insert a shim in between the jaws and the pipe. This shim will concentrate the pressure on to the pipe and move the pipe into alignment.
松开一个夹具，在管子和夹具间插入垫片。此垫片应在与管子同心的条件下施加压力，挪动管子进行找正。

It is important to remember that, if the clamp has been opened during operation, the shaving operation must be repeated.
如果在操作过程中打开了卡具，那么此管子需重新铣削。

The final acceptable misalignment tolerance between two components to be welded is 1 mm for pipe wall thickness below 10 mm and 10 % of the wall thickness for pipe wall thickness above 10 mm.
管材两端的错位量为 1mm(管壁厚度小于 10mm)和管壁厚度的 10%(管壁厚度大于 10mm)。

The acceptable gap between two components during alignment check shall Only per Manufacturer's Recommendation.
检查找正时两段管子之间的允许间隙要达到厂家允许标准。

If the required tolerance for alignment and clearance are not achieved, the shaving operation shall be repeated until the required tolerances are met.
如果错位量超过了允许值，则该管段需重新铣削直到满足要求。

Once the pipes are correctly aligned, separate the pipes again for cleaning. Remove chips inside the pipes on both sides, all chips scattered under the pipes and also inside the machine. Otherwise, they will stick to the mirror (heating plate) later while re-heating. Remove the chips by using a brush or a small hook made out of a thin steel wire.
如果管段满足要求，则分开管段进行清理。清除管段两端内部的碎屑，管段下面的碎屑及机器内的碎屑。否则，当加热时，碎屑会附着在加热板上。应采用刷子或用细钢丝做的钩进行清理工作。

Never put any dirty gloves inside the pipe or remove the chips with hands. Do not touch the shaved pipe ends.
不能把脏手套放入管内或用手清除碎屑。不能触碰铣削好的管端。

Always clean the weld surface with a lint free, before the mirror (Heating Plate)is introduced on the alignment jig.
在加热板放入夹具前，用干净的抹布清理焊接的表面。

C Heating of Surface 表面加热

All staff shall master the parameters required by the process card before the heating plates put in the fixtures.

在加热板放入夹具前，所有的工作人员都应掌握操作中工艺卡要求的参数。

The jig shall be operated without the heating plate in position to measure the required pressure to pull the pipe towards the heating plate. This pressure shall be measured from the pressure gauge on the control unit.
在放入加热板前，应先测试夹具把管段拉向加热板所需的压力。该压力用控制单元的压力表测试。

The pipe pulling pressure shall be adjusted by the pressure regulator provided on the control unit. This pressure shall be enough to just move pipe components.
拉动管子的压力由控制单元的压力调节器进行调节。此压力值只要能使两个管段能相互接触就足够了。

This pulling pressure shall be recorded for each joint welding operation by the welder. The pressure mentioned on the welding parameter card for other operation (such as bead up pressure, heat soaking pressure etc.) shall be added to this pulling pressure for welding operation.
每道焊口的拉拽压力都应作好记录。其它操作(如加热压力，吸热压力等)焊接参数卡上压力值应加入焊接期间的拉拽压力。

Also check the mirror temperature. With pyrometer Normally, the mirror has a yellow or red lamp on the control unit, which indicates the operator, whether the mirror has reached working temperature.
检查加热板的温度。通常，加热板在控制单元有一个黄色或红色的指示灯用于显示加热板是否已达到了工作温度。

To make sure there is no cold air flowing through the pipe, place some plastic bags on each end of the pipe, this will prevent the air from cooling the mirror on one side.
确保没有冷空气在管内流动。在每个管端用塑料袋封堵以阻止空气流动到加热上。

Push the pipes together against the mirror At the preset heating pressure.
向加热板同时推动两管段并把压力升到加热压力。

This pressure needs to be maintained until the required Bead-up height has been reached. The bead up height is the height of the bead, which is pressing up against the mirror.
该压力应维持到卷边高度达到要求。卷边高度为管端沿加热板卷起的高度。

As soon as the Bead up height has been reached, release the pressure down to the Heat Soak pressure. Heat soak pressure is the pressure maintained during the Heat Soak time.
当卷边高度达到要求时，将压力降至吸热压力。吸热压力是指在吸热阶段维持的压力。
As per

recommended welding parameter, the heat soaking pressure is 0 Mpa. But make sure during the heat soak time, the welding components should touch the mirror.
按推荐的焊接参数，吸热压力为 0Mpa。在吸热阶段应确保管段接触到加热板。

As soon as the heat soak time has elapsed, separate the pipes, remove the mirror,

and then press together.
当吸热时间达到后，立即分开管段，取出加热板，然后合拢两管端。

D Fusion of Surfaces 表面热熔

This operation has to be done quite fast, since there is actually a time limit.
本操作过程需在很短的时间内完成，因为本操作有时间限制。

“Transfer time” (Switch time) is the time from the removal of the mirror until the two pipes are pressed together and reaches the Fusion pressure.
“切换时间”是指从移开加热板到两管段合拢到一起并达到热熔压力的时间。

Fusion pressure is the pressure that shall reach after Transfer time and maintained during the Cooling time.
热熔压力是指在切换时间后达到并在冷却期间维持的压力。

E Cooling of Joint 接缝冷却

Cooling time is the time in which the pipe has to be left undisturbed. Under no circumstances shall the clamps be opened or the pressure released until the cooling time has elapsed.
冷却时间是指不触碰管子这段时间。冷却后卸压并松开卡具。

Release the fusion pressure, when the fusion joint temperature reaches the ambient temperature.
当热熔接缝的温度达到环境温度时释放热熔压力。

Operate the welding jig and remove the welded components from holder clamp.
打开焊接夹具并将从夹具上移走管件

For the specified cooling time of the fusion welding joint, see sheet-A:
熔焊缝具体冷却时间见表 A：

Pipe thickness 管壁厚度（mm）	Cooling time (minutes) 冷却时间（分钟）
5mm	5
5-10mm	5-10
10-15mm	10-15
15-20mm	15-20
20-30mm	20-30
30-35mm	30-40
35-46mm	40-55
46-56mm	55-70
56-66mm	70-85
66-76mm	85-100

1.1.1.7 Fusion welding environment control 熔焊环境控制

Effective weather-proof protections like the iron sheet or tarpaulin cover for the erection of the removable light-duty welding sheds before the piping assembly or welding.

熔焊时必须采取有效的防风防尘防雪等防护措施，如用铁皮或棚布遮挡，制做可移动式小型焊接防护棚等，管道组对或者焊接前必须提前准备好。

2-3 sun lights shall be applied for heating in the protection sheds when the ambient temperature is below 5 Celsius degrees and the piping fusion welding shall not be implemented when the temperature up to 5 Celsius degrees.
环境温度低于 5℃时，用两至三盏太阳灯在防护棚里进行加热，升温到正常温度 5℃后方可进行管道熔焊。

The protecting sheds shall be kept warm inside in snowy weathers if the necessary welding works needed due to the construction progress.
遇到风雪天气，如工程进度需要管道焊接时，防护棚必须严实，无漏风漏雪现象。

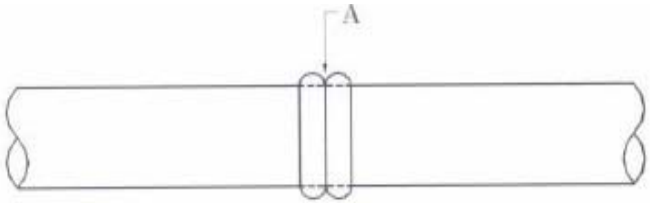
Dust around the pipe end shall be cleaned before welding, and for those with severe splodge shall be wiped by non-fabric clothing.
熔焊前必须对管口的灰尘等污迹进行擦洗，较重的污迹用肥皂水溶液清洗或擦试，然后用无纺布擦干。

1.1.1.8 Inspection of Weld Seam 熔焊缝检查

Inspect the weld joint. The bead up and fusion should be uniform all around the joint.接缝必须均匀加热并热熔。

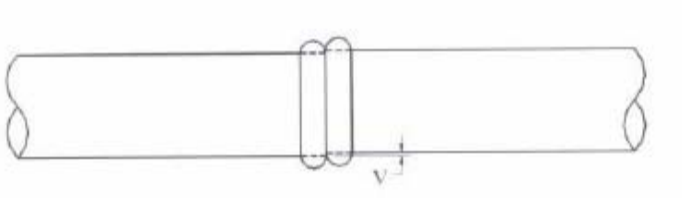
If the weld joint visual appearance is not acceptable or any misalignment or distortion noticed on the joint, the weld shall be completely cut out and new joint shall be made as per the welding procedure.
如果焊缝外观不合格或未找正或有变形产生，则该焊缝需完全切掉并按焊接程序重新进行焊接。

The clearance (A) between the fusion joints after welding shall not be lower than the piping surface (see schematic 1).
熔接工作完成后熔接缝之间行成的间隙（A）在整个周长上都不得低于管道表面。 图（1）

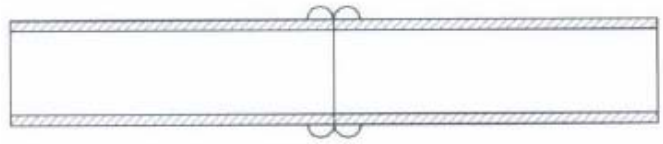


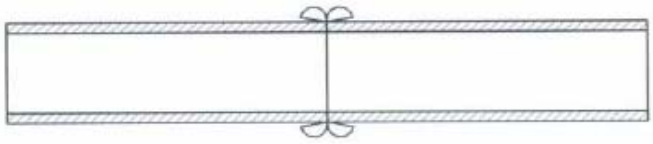
Schematic 1 图（1）

The staggered edges (V) of the fusion welding joints shall be no larger than 10 % of the minimum wall thickness of the piping/component. See schematic 2
熔接缝的错边（V）不得超过管道/配件最低管壁厚度的 10%。图（2）

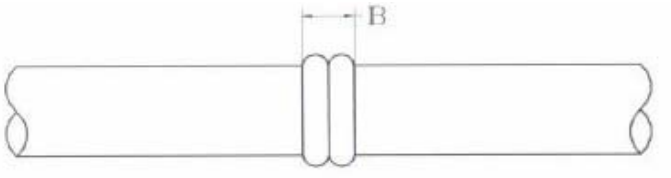


The outside welding joints s all of the piping and component, as shown in the fusion joint schematics: certified (3) and unqualified (4).
外部的焊缝必须完全紧贴管道以及配件的管壁，如图：合格的熔焊缝图（3），不合格的熔焊缝图（4）





The width of the general fusion welding joint shall be like the Schematic (5) Sheet (B),
,一般熔焊缝宽度如图（5）表（B）



Sheet (B)表（B）

Pipe wall thickness 管壁厚度（mm）	Approximate fusion joint width (B) 近似熔焊缝宽度（B）		Pipe wall thickness 管壁厚度（mm）	Approximate fusion joint width (B) 近似熔焊缝宽度（B）	
	Minimum 最小值（mm）	Max 最大值（mm）		Minimum 最小值（mm）	Max 最大值（mm）
3	4	6	27	15	20
4	4	7	30	16	20.5

5	5	8	34	17	22
6	6	9	40	17.5	23
8	7	9.5	45	20	25.4
9	8	11	50	22	27
11	9	13	55	24	30
13	9.5	14	60	25.4	32
16	11	15	65	28.5	36.5
18	13	16	70	30	38
19	13	17	75	32	40
22	13	17	80	33	43
24	14.5	19	85	35	44
			90	38	46

Special-assigned quality inspectors shall be sent for the tracking inspection of the site HDPE piping and the Welding Daily shall be edited, and the joint serial number and operator of each joint shall be documented and recorded as the original files.
派专业的质检员对现场 HDPE 的管道进行跟踪检查，并做好每天的焊接日报，对每条焊缝编号和操作人进行记录，并作原始档案保存。

The NDE inspection shall be implemented for the welding joints after the surface NDE inspection shall conform to project specification SP-50-003 ultrasonic TOFD Inspection for HDPE pipe and site requirements.
熔接缝外表检验合格的焊缝按规范和现场要求进行 NDE 检测。

The repair of the unqualified fusion welding joints shall be implemented according to the plans formulated by the site professional engineers and approved by the related management personnel.
对不合格的熔接焊缝返修，要根据由现场专业工程师制定方案并经有关管理人员批准方可进行。

Those unqualified for 2 times or above continuously shall be paused for inspection and modification, and the examination for the related personnel shall be supplied, if necessary. Those operators disobeyed the specification severely shall be punished to stop the works.
对连续累次不合格达到两次向上者，必须停顿检查，进行整改，找出原因所在，必要时对有关人员进行再一次的考试，考试合格后方可进行作业。对严重违规操作人员进行永久停止作业的处罚。.

1.1.1.9 Faults and fault reasons of the HDPE pipe welding joints: Sheet (C)
HDPE 管熔接接头的故障和故障原因：表（C）

Sheet (C) 表（C）

Existing Defects 存在的缺陷	Fault Reasons 故障原因

The bead width in one side of the fusion welding joint is larger than that in the other side 一条熔合缝一边焊珠宽度大于另一边焊珠宽度	The equipment was damaged for the welding was not adjusted and the incomplete turning forces the ends un-uniformed heating. 未对准，部件在夹钳内滑动，设备破损，不完整的端面车削，加热器板一侧比另一侧热，管端施加了不一致的压力。
The bead is not rolled in the piping surface 焊珠未翻滚至管道表面	Inadequate heating and fusion welding to the shallow V grove; Inadequate heating and excessive fusion on the deep V grove. 浅 V 型凹槽-不充分的加热和不充分的熔接力 深 V 型凹槽-不充分的加热和过度的熔接力
Squared outside bead edge 方形的外部焊珠边缘	Pressure forced during heating 在加热期间施加了压力
Excessive dual bead width 过度的双焊珠宽度	Excessive heating and fusion welding 过度加热，过度的熔接力
Bead with flat top 焊珠具有平坦的顶部	Excessive heating and fusion welding 过度加热，过度的熔接力
The beads are too much small 焊珠太小	Inadequate heating or fusion welding 不充分的加热或熔接力
The beads are too large 焊珠太大	Excessive heating hours 过度的加热时间
Bead surface with rough and abrasive paper-shaped bubbles or pits 粗糙、砂纸状，有气泡或者麻点的熔合焊珠表面。	Hydrocarbon pollution 碳氢化合物污染
The dual V groove is too deep 双 V 型凹槽太深	Excessive fusion welding and pressure forced during inadequate heating 过度的熔接力，不充分的加热，在加热期间施加了压力。
The beads around the piping is un-uniformed 管道周围不一致的焊珠规格	The equipment was damaged for the welding was not adjusted 未对准，有缺陷的加热工具，设备破损，不完整的端面车削
The 3rd kind beads 第三种焊珠	Excessive fusion welding 过度的熔接力
Bead with flat top 焊珠具有平坦的顶部	Excessive fusion welding and overheating 过度的熔接力，过热。