TETRA TECH

AGNICO EAGLE

MELIADINE PROJECT
BLOCK 007 – PERMANENT PUMPING STATIONS
PACKAGE 6515-S-265-094
FUNCTIONNAL DESCRIPTION

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Revision 0

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1. DOCUMENT OBJECTIVE

This document describe the programming of the control logic to be implement for the control system of the 2 pumping stations, 65PST40001 (CP-1) and 65PST40005 (CP-5) for the Agnico Eagle Meliadine mine Project located at Meliadine Lake in Nunavut.

The 65PST40005 pumping station is located upstream approximatively 1 km from the 65PST40001 which is located upstream of the water treatment plant near Meliadine Lake. Each pumping station will have their own PLC and HMI, the programming include both 65PST40001 and 65PST40005 new PLC and HMI.

2. SYSTEM DESCRIPTION

Each pumping station consist of a sump pit, 2 submersibles pumps, piping, valves, electrical equipment, instrumentation and control equipment's all installed in a heated building. Depending of the pumping capacity requirement, two pumps could be working at the same time, however if only one pump is required, the other will be in standby for back-up. .

2.1 Pumping station 65PST40001 (CP-1)

Surface water from CP-1 pond is brought into the 5.7 m deep sump of 65PST40001 pumping station using two HDPE pipes (400 mm and 500 mm). To pump the water from the sump to the Effluent Water Treatment Plant (EWTP), two 110HP submersible pumps (65PSU40001A and B), with variable speed drives (VFD) are used

An ultrasonic level transmitter 65LIT6950227 measure the sump water level and transfer the signal to the control panel (PLC1) for pump control and indication on the local HMI. A 100 mm drain line with an automatic butterfly valve 65FV6950229 is connected to the discharge line near the pumps to drain the discharge main line back to the sump when the pumps stop. This draining automatic procedure helps draining the portion of pipeline higher than the pumping station and prevent this section to freeze in case of pump failure by example.

Two magnetic flowmeters will be installed on the 400 mm (16") main line going to Meliadine Lake. One flowmeter is located at the EWTP station(65FIT6930001) and the second one downstream of the EWTP, near Meliadine Lake (65FIT6930020). Both flowmeters will be used to check for a possible leak in the line by comparing their readings in real time. , one flowmeter will be supplied loose by the pumping stations manufacturer, the other one by the EWTP manufacturer. Leak detection programing will be done in the EWTP station control system and therefore is not included in this document.

The EWTP is located near CP-1 pond, it treats water incoming from pond CP-1 (and CP-5) before it will pumped to the Meliadine lake. The EWTP package is supplied by others.

2.2 Pumping station 65PST40005 (CP-5)

Surface water from CP-5 pond is brought into the 3.47 m deep sump of 65PST40005 pumping station using two HDPE pipes (400 mm and 500 mm). To pump the water from the sump to the CP-1, two 45HP submersible pumps (65PSU40005A and B), with soft starts are used

An ultrasonic level transmitter (65LIT6950207) measures the sump water level and transfers the signal to the control panel (PLC5) for pump control and indication on the local HMI. A 100 mm drain line with an automatic butterfly valve (65FV6950209) is connected to the discharge line near the pumps to drain the discharge main line back to the sump when the pumps stop. This draining automatic procedure helps draining the portion of pipeline higher than the pumping station and prevent this section to freeze in case of pump failure by example.

Two magnetic flowmeters are installed on the 400 mm main line going to the CP-1. One flowmeter (65FIT6950211) is located close to the pumps' discharge and the second one (65FIT6950213) at the end of the main line, near CP-1 pond. Both flowmeters, which will be used to detect possible leaks in real time by comparing their readings, will be supplied loose by the pumping stations manufacturer. As opposed to the 65PST40001 station, leak detection programing will be done in the PLC-5.

3. 65PST40001 (CP-1) CONTROL

In the first phase of the project, the water volumes in CP-1 require only one pump to be in operation. The second pump will serve mainly as a spare.

Each pump is equipped with a 3 positions selector Manual/Auto/Maintenance at the local HMI, 65HIK6950220 for pump 65PSU40001A, 65HIK6950225 for pump 65PSU40001B, and either a start/stop button for each pump, 65HS6950220 and 65HS695225. The selectors function are as followed:

Manual (left) :	The pump start and stop with the start and stop buttons on the HMI. The pump respect the interlocks (Low low level for example).
Auto (middle) :	The pumps will start and stop automatically according to the PLC command.
Maintenance (middle) :	The pump jog with the start button on the HMI, the pump doesn't respect the interlocks.

3.1 Manual Mode

In this mode the PLC controls the pump via the Start/Stop buttons on the HMI. The pump will respect the interlocks (if the low low level is reached, it won't start back). This mode should be used to keep the pump stopped or for manual operation.

3.2 Maintenance Mode

The pump is not running, it will start when the start button on the HMI is held and automatically stopped when it's release, it does not respect the interlocks.

3.3 Auto Mode

This is the normal operating mode. During normal operation, the selector on the local HMI is set to AUTO position therefore the PLC1 will start and stop the pump and regulating the pump speed according to the process conditions and demand from the EWTP PLC.

The PLC will control the selected pump in this mode, the back-up pump will be in Manual.

1. Pump start-up sequence

Starting interlock:

The following interlock are checked to authorize the pump start.

- No Emergency-Stop
- Pump in Auto mode
- VFD is ready
- No low level in the sump pit
- EWTP starting command flag is on

The pump cannot start only by the CP-1 local interlock, the EWTP system will initiate the starting sequence depend on his demand. When all local conditions are true, the pump is ready to start and wait from the EWTP start command, when this command is initiate, the pump starting sequence begin as follows:

- Starting the pump in auto mode 65PSU40001A or B
- Close drain valve 65FV6950229
- Signal output 65FIC6930001 to VFD set to minimum, (?? %, to come)

Once the pump is started, the following confirmations are check

- The pump is running
- The drain valve 65FV6950229 is close after 30 seconds (actuator travel time is 14 sec)

If these feedback are not confirmed, an alarm shall be initiate at the local HMI and at the EWTP control system. .

2. Pump speed control

When the pump is running and the drain valve is confirm close, the PLC control the pump speed by the speed Modbus Ethernet register in the VFD according to the 65FIC6930001 output that set the pump speed.

Depending on the flow coming from the CP1 pond and the EWTP capacity, the sump pit level will vary and act as a buffer. The speed set point of the pump will be dictated by the EWTP plant PLC, while the CP-1 PLC will transfer the speed require to the VFD by the local Ethernet network. Therefore the control strategy for the pump speed control will be detailed in the EWTP functional description.

3. Pump stop sequence

The pump could be stopped either by the EWTP plant (normal operating mode) or by the local CP-1 PLC if one of the interlock listed in 3.3.1 is disable.

- Emergency-Stop is activated
- Pump not in Auto mode
- VFD is not ready
- Low level in the sump pit

Under certain circumstances, if the water level becomes too low in the sump, the pump shall be stopped to avoid cavitation.

When the water level reaches a low level (?? %, to come) (65LAL6950227), the pump will be stopped with the following sequence.

- The pump is stop.
- The drain valve 65FV6950229 is open and remains open until the pump is start again.
- Motor status feedback and valve position is sent to the PLC.

If these feedbacks are not confirmed, an alarm shall be initiate at the HMI.

The pump in Auto mode will remain stopped until the level rise above the high level set point 65LAH6950227 and the EWTP PLC initiate the start command, then the start sequence will be initiated again. The pump will stop with the low level 65LAL6950227.

4. Emergency stop 65HSS6950220

An Emergency Stop push-bouton, 65HSS690220 located near the pump will stop the pump immediately (no matter what the process conditions or alarms are). This Emergency Stop shall have a protective cover to avoid accidental actuation.

5. Drain Valve 65FV6950229

The drain valve 65FV6950229 is equipped with a 3 positions selector, 65HIK6950229 (Manual/Auto/Maintenance) and a Close/Open buttons on the HMI, 65HS6950229. The normal operating mode is Auto, in this mode the PLC control the valve opening and closing. In manual mode, the valve can be open and close with the HMI in respect with the interlock, while in maintenance mode the valve is close and can be openned by holding the open command on the HMI independently of the interlocks.

3.4 Alarm List

The following alarms shall be programmed in the HMI 65HMI69501.

Alarm tag #	Description	Set point
65LAHH6950227	High High level Alarm sump CP-1	To come
65LAH6950227	High level Alarm sump CP-1 (Start pump)	To come
65LAL6950227	Low level Alarm sump CP-1 (Stop pump)	To come
65LALL6950227	Low Low level Alarm sump CP-1	To come
65XA40001A/1	65VFD40001A motor VFD fault	n/a
65XA40001A/2	65PSU40001A motor GFI Trip	n/a
65HA40001A	65PSU40001A motor start problem	n/a
65XA40001B/1	65VFD40001B motor VFD fault	n/a
65XA40001B/2	65PSU40001B motor GFI Trip	n/a
65HA40001B	65PSU40001B motor start problem	n/a
65ZA6950229	Drain valve malfunction	n/a
65HA6950220	Emergency stop activated	n/a

4. 65PST40005 (CP-5) CONTROL

Depending of the flow coming from the CP-5 pond, one or two pump will be required, therefore the PLC will controlled one or two pump at the same time. If only one pump is required, the second pump will be used as back-up. CP-5 pumps do not have VFD, only soft start, and therefore they are on-off controlled.

Each pump is equipped with a 3 positions selector Manual/Auto/Maintenance at the local HMI, 65HIK6950200 for pump 65PSU40005A, 65HIK6950205 for pump 65PSU40005B, and either a start/stop button for each pump, 65HS6950200 and 65HS695205. The selectors function are as followed:

Manual (left) :	The pump start and stop with the start and stop buttons on the HMI. The pump respect the interlocks (Low low level for example).
Auto (middle) :	The pumps will start and stop automatically according to the PLC command.
Maintenance (right) :	The pump jog with the start button on the HMI, the pump doesn't respect the interlocks.

4.1 Manual Mode

In this mode the PLC controls the pump via the Start/Stop buttons on the HMI. The pump will respect the interlocks (if the low low level is reached, it won't start back). This mode should be used to keep the pump stopped or for manual operation.

4.2 Maintenance Mode

The pump is not running, it will start when the start button on the HMI is held and automatically stopped when it's release, it does not respect the interlocks.

4.3 Auto Mode

This is the normal operating mode. During normal operation the selector is set to AUTO position therefore the PLC5 will start and stop the pump according to the process signal from the level transmitter.

1. Pump start-up sequence

Starting interlock

The following interlock are checked to authorize the pump start.

- No Emergency-Stop
- Pump in Auto mode
- Soft start is ready

When all these conditions are true, the pump is start depending on the water level in the sump pit. When 65LIT6950207 reaches a High level at ?? % (to come), 65LAH6950207, the starting sequence begins as follow:

- Starting the pump in auto mode 65PSU40005A or B
- Close drain valve 65FV6950209

Once the pump is started, the following confirmation are check

- The pump is running.
- The drain valve 65FV6950209 is close after 30 seconds (actuator travel time is 14 sec).

If theses feedback are not confirms, an alarm shall be initiate at the HMI.

2. Pump stop sequence

The pump in Auto will run until the sump pit water level reach is low level alarm 65LAL6950207, than the pump is stopped with the following sequence:

- The pump is stopped.
- The drain valve 65FV6950209 is open and remains open until the pump is start again.
- Motor status feedback and valve position is sent to the PLC.

If theses feedback are not confirms, an alarm shall be initiate at the HMI.

The pump in Auto mode will remain stop until the level 65LIT6950207 rise and reach the high level 65LAH6950207, than the start sequence will be initiated again.

3. Emergency Stop 65HSS6950200

   An Emergency Stop push-bouton 65HSS6950200 located near the pumps will stop the pump immediately no matter what the process conditions or alarm are. This Emergency Stop shall have a protective cover to avoid accidental actuation.

4. Flowmeter readings comparison

   As describe in section 2.2, two magnetic flowmeter 65FIT6950211 and 65FIT6950213 are install on the main water line going from the pumping station 65PST40005 to CP1 pond. The flow signal from both meter are send to the PLC and display on the HMI in engineering units, 65FI6950211 and 65FI6950213.

   The mains goal of the flowmeters is to detect a possible leak in the pipe by comparing the 2 flow in real time and generate an alarm at the HMI if the difference between the two flowmeter readings is more than 10% of the actual flow.

5. Drain Valve 65FV6950209

   The drain valve 65FV6950209 is equipped with a 3 positions selector, 65HIK6950209 (Manual/Auto/Maintenance) and a Close/Open buttons 65HS6950209 on the HMI. The normal operating mode is Auto, in this mode the PLC control the valve opening and closing. In manual mode, the valve can be open and close with the HMI in respect with the interlock, while in maintenance mode the valve is close and can be openned by holding the open command on the HMI independently of the interlocks.

4.4 Alarm List

The following alarms shall be programmed in the 65HMI69505

Alarm tag #	Description	Set point
65LAHH6950207	High High level sump CP-5	To come
65LAH6950207	High level Alarm sump CP-5 (Start pump)	To come
65LAL6950207	Low level Alarm sump CP-5 (Stop pump)	To come
65LALL6950207	Low Low level Alarm sump CP-5	To come
65FDAH6950213	High Flow diff 65FI6950213 and 65FI2950211	To come
65XA40005A/1	65PSU40005A motor GFI Trip	n/a
65XA40005A/2	65PSU40005A motor Overload Trip	n/a
65HA40005A	65PSU40005A motor start problem	n/a
65XA40005B/1	65PSU40005B motor GFI Trip	n/a
65XA40005B/2	65PSU40005B motor Overload Trip	n/a
65HA40005B	65PSU40005B motor start problem	n/a
65ZA695209	Drain valve malfunction	n/a
65HSS6950200	Emergency stop activated	n/a

APPENDIX E

Water Quality Testing of EWTP Discharge

		Pre-treatment EWTP		
Date		**17-Jun-18**	**27-Jun-18**	**1-Jul-18**
field pH		7.33	8.5	8.75
field cond.		888	1572 us	1528 uS
field temp		3	2.1	9
Water Bodie: CP1 (MEL-14)				
Year		2018	2018	2018
Date sampled		17-juin-18	27-juin-18	01-juil-18
Lab Reference		B8F2110	B8G3414	B8G4482
LAB		Maxxam	Maxxam	Maxxam
Parameters	**Units**			
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	33	51	56
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	<1.0	<1.0
Total Ammonia-N	mg/L	2.4		2.7
Conductivity	µmhos/cm	840	1500	1600
Total Dissolved Solids (TDS)	mg/L	**540**	**945**	**950**
Free Cyanide (Cn)	mg/L	<0.0010		<0.001
Total Kjeldahl Nitrogen (TKN)	mg/L	2.2		3.5
Dissolved Organic Carbon (DOC)	mg/L	5.3		8.5
Total organic carbon (T.O.C.)	mg/L	5.9		9.8
Orthophosphate (P)	mg/L	0.11		0.015
pH	pH	7.45	7.58	7.62
Total Phosphorus (P)	mg/L	0.15		0.1
Total Suspended Solids (TSS)	mg/L	9	4	30
Dissolved Sulphate (SO4)	mg/L	31	46	52
Total Cyanide (Cn)	mg/L	<0.0050		<0.0050
Turbidity	NTU	3	2.1	3.7
Alkalinity (Total as CaCO3)	mg/L	33	51	56
Dissolved Chloride (Cl)	mg/L	180	350	390
Nitrite (as N)	mg/L	0.07		0.096
Nitrate (as N)	mg/L	4.78		5.54
Nitrite-Nitrate (as N)	mg/L	4.85		5.63
Radium-226	Bq/L	<0.0050		<0.0050
Total Oil & Grease	mg/L	<0.50		1.3
Mercury (Hg)	mg/L	<0.00001		<0.00001
Dissolved Mercury (Hg)	mg/L	<0.00001		<0.00001
Total Hardness	mg/L	201	400	418
Total Aluminium (Al)	mg/L	0.315		0.404
Total Antimony (Sb)	mg/L	<0.00050		<0.00050
Total Arsenic (As)	mg/L	0.00216		0.00213
Total Barium (Ba)	mg/L	0.0491		0.1
Total Beryllium (Be)	mg/L	<0.00010		<0.00010
Total Boron (B)	mg/L	0.065		0.104
Total Cadmium (Cd)	mg/L	0.000023		0.00003
Total Chromium (Cr)	mg/L	0.001		0.0011
Total Copper (Cu)	mg/L	0.00336		0.0025
Total Iron (Fe)	mg/L	0.58		0.711
Total Lead (Pb)	mg/L	0.00062		0.00055

		Pre-treatment EWTP		
Date		**17-Jun-18**	**27-Jun-18**	**1-Jul-18**
field pH		7.33	8.5	8.75
field cond.		888	1572 us	1528 uS
field temp		3	2.1	9
Water Bodie: CP1 (MEL-14)				
Year		2018	2018	2018
Date sampled		17-juin-18	27-juin-18	01-juil-18
Lab Reference		B8F2110	B8G3414	B8G4482
LAB		Maxxam	Maxxam	Maxxam
Parameters	**Units**			
Total Lithium (Li)	mg/L	0.0555		0.115
Total Manganese (Mn)	mg/L	0.169		0.376
Total Molybdenum (Mo)	mg/L	<0.0010		<0.0010
Total Nickel (Ni)	mg/L	0.0029		0.0039
Total Selenium (Se)	mg/L	<0.00010		<0.00010
Total Silver (Ag)	mg/L	<0.000020		<0.000020
Total Strontium (Sr)	mg/L	1.25		2.48
Total Thallium (Tl)	mg/L	0.000022		0.000028
Total Tin (Sn)	mg/L	<0.0050		<0.0050
Total Titanium (Ti)	mg/L	0.0102		0.0059
Total Uranium (U)	mg/L	0.00035		0.00061
Total Vanadium (V)	mg/L	<0.0050		<0.0050
Total Zinc (Zn)	mg/L	0.0074		0.0063
Total Calcium (Ca)	mg/L	62.8		131
Total Magnesium (Mg)	mg/L	10.7		22.1
Total Potassium (K)	mg/L	6.06		11.3
Total Sodium (Na)	mg/L	55.2		108
BTEX & F1 Hydrocarbons				
Benzene	ug/L	<0.20		<0.20
Toluene	ug/L	<0.20		<0.20
Ethylbenzene	ug/L	<0.20		<0.20
o-Xylene	ug/L	<0.20		<0.20
p+m-Xylene	ug/L	<0.40		<0.40
Total Xylenes	ug/L	<0.40		<0.40
F1 (C6-C10)	ug/L	<25		<25
F1 (C6-C10) - BTEX	ug/L	<25		<25
Hydrocarbons (L) (Fraction F1 (C6-C10))	µg/L			
Hydrocarbons (L) (Fraction F2 - F4))				
F2 (C10-C16 Hydrocarbons)	µg/L	<100		<100
F3 (C16-34 Hydrocarbons)	µg/L	<200		<200
F4 (C34-50 Hydrocarbons)	µg/L	<200		<200
Reached Baseline at C50	µg/L	yes		Yes
Diesel (C10-C24)	µg/L			
Diesel (C11-C32)	µg/L			
F4G-sg (Grav. Heavy Hydrocarbons)	ug/L			
1,4-Difluorobenzene	%	99		105

		Pre-treatment EWTP		
Date		**17-Jun-18**	**27-Jun-18**	**1-Jul-18**
field pH		7.33	8.5	8.75
field cond.		888	1572 us	1528 uS
field temp		3	2.1	9
Water Bodie: CP1 (MEL-14)				
Year		2018	2018	2018
Date sampled		17-juin-18	27-juin-18	01-juil-18
Lab Reference		B8F2110	B8G3414	B8G4482
LAB		Maxxam	Maxxam	Maxxam
Parameters	**Units**			
4-Bromofluorobenzene	%	97		103
D10-Ethylbenzene	%	94		96
D4-1,2-Dichloroethane	%	98		111
o-Terphenyl	%	96		100
Dissolved Hardness	mg/L	28.9		421
Dissolved Aluminium (Al)	mg/L	0.0613		0.0879
Dissolved Antimony (Sb)	mg/L	<0.00050		<0.00050
Dissolved Arsenic (As)	mg/L	0.00076		0.00133
Dissolved Barium (Ba)	mg/L	0.0082		0.0998
Dissolved Beryllium (Be)	mg/L	<0.00010		<0.00010
Dissolved Boron (B)	mg/L	0.069		0.106
Dissolved Cadmium (Cd)	mg/L	0.000013		0.000024
Dissolved Chromium (Cr)	mg/L	<0.0010		<0.0010
Dissolved Copper (Cu)	mg/L	0.00104		0.00175
Dissolved Iron (Fe)	mg/L	0.0355		0.0893
Dissolved Lead (Pb)	mg/L	<0.00020		<0.00020
Dissolved Lithium (Li)	mg/L	<0.0020		0.116
Dissolved Manganese (Mn)	mg/L	0.128		0.328
Dissolved Molybdenum (Mo)	mg/L	0.0011		<0.0010
Dissolved Nickel (Ni)	mg/L	<0.0010		0.003
Dissolved Selenium (Se)	mg/L	<0.00010		<0.00010
Dissolved Silver (Ag)	mg/L	<0.000020		<0.000020
Dissolved Strontium (Sr)	mg/L	0.0452		2.53
Dissolved thallium (Tl)	mg/L	<0.000010		0.00003
Dissolved Tin (Sn)	mg/L	<0.0050		<0.0050
Dissolved titanium (Ti)	mg/L	<0.0050		<0.0050
Dissolved Uranium (U)	mg/L	<0.00010		0.00059
Dissolved Vanadium	mg/L	<0.0050		<0.0050
Dissolved Zinc	mg/L	0.0051		<0.0050
Dissolved Calcium (Ca)	mg/L	7.76		131
Dissolved Magnesium (Mg)	mg/L	2.3		22.6
Dissolved Potassium (K)	mg/L	3.9		11.5
Dissolved Sodium (Na)	mg/L	14.6		109
Dissolved Sulphur (S)	mg/L	-		
Reactive Silica (Si)	mg/L	0.83		0.31
Cobalt (Co)	mg/L			

		Pre-treatment EWTP		
Date		**17-Jun-18**	**27-Jun-18**	**1-Jul-18**
field pH		7.33	8.5	8.75
field cond.		888	1572 us	1528 uS
field temp		3	2.1	9
Water Bodie: CP1 (MEL-14)				
Year		2018	2018	2018
Date sampled		17-juin-18	27-juin-18	01-juil-18
Lab Reference		B8F2110	B8G3414	B8G4482
LAB		Maxxam	Maxxam	Maxxam
Parameters	**Units**			
Cobalt (Co)	mg/L			
Daphina Toxicity	**U.T (Toxic Units)**			
Rainbow Trout Toxicity	**U.T (Toxic Units)**			

Post treatment EWTP

Date		**License A 2AM-MEL1631 Part F, Item 3**	**1-Jul-18**
field pH			7.35
field cond.			1510 uS
field temp			10.4
Water Bodie: EWTP-POST TREATMENT (MEL-14)			**2018**
Year			
Date sampled			1-Jul-18
Lab Reference			B8G4482
LAB			Maxxam
Parameters	**Units**		
Bicarb. Alkalinity (calc. as CaCO3)	mg/L		34
Carb. Alkalinity (calc. as CaCO3)	mg/L		<1.0
Total Ammonia-N	mg/L		2.6
Conductivity	µmhos/cm		1600
Total Dissolved Solids (TDS)	mg/L	Max Avg (1400 mg/L) Max grab (1400 mg/L)	930
Free Cyanide (Cn)	mg/L		0.0027
Total Kjeldahl Nitrogen (TKN)	mg/L		2.8
Dissolved Organic Carbon (DOC)	mg/L		4.8
Total organic carbon (T.O.C.)	mg/L		5.9
Orthophosphate (P)	mg/L		<0.01
pH	pH	Max avg (6.0 to 9.5) max grab (6.0 to 9.5)	7.11
Total Phosphorus (P)	mg/L	Max avg (2 mg/L) Max grab (4 mg/L)	0.034
Total Suspended Solids (TSS)	mg/L	Max avg (15 mg/L) Max grab (30 mg/L)	**10**
Dissolved Sulphate (SO4)	mg/L		49
Total Cyanide (Cn)	mg/L	Max avg (0.5 mg/L) Max grab (1.0 mg/L)	<0.005
Turbidity	NTU		**0.7**
Alkalinity (Total as CaCO3)	mg/L		34
Dissolved Chloride (Cl)	mg/L		400
Nitrite (as N)	mg/L		0.092
Nitrate (as N)	mg/L		5.52
Nitrite-Nitrate (as N)	mg/L		5.61
Radium-226	Bq/L		<0.0050
Total Oil & Grease	mg/L		1.30
Mercury (Hg)	mg/L		<0.00001
Dissolved Mercury (Hg)	mg/L		<0.00001
Total Hardness	mg/L		400
Total Aluminium (Al)	mg/L	Max avg (2 mg/L) Max grab (3 mg/L)	1.22

Post treatment EWTP

Date		**License A 2AM-MEL1631 Part F, Item 3**	**1-Jul-18**
field pH			7.35
field cond.			1510 uS
field temp			10.4
Water Bodie: EWTP-POST TREATMENT (MEL-14)			**2018**
Year			
Date sampled			1-Jul-18
Lab Reference			B8G4482
LAB			Maxxam
Parameters	**Units**		
Total Antimony (Sb)	mg/L		<0.00050
Total Arsenic (As)	mg/L	Max avg (0.3 mg/L) Max grab (0.6 mg/L)	0.0011
Total Barium (Ba)	mg/L		0.0979
Total Beryllium (Be)	mg/L		<0.00010
Total Boron (B)	mg/L		0.1
Total Cadmium (Cd)	mg/L		0.000024
Total Chromium (Cr)	mg/L		<0.0010
Total Copper (Cu)	mg/L	Max avg (0.2 mg/L) Max grab (0.4 mg/L)	0.00129
Total Iron (Fe)	mg/L		0.118
Total Lead (Pb)	mg/L	Max avg (0.2 mg/L) Max grab (0.4 mg/L)	0.00033
Total Lithium (Li)	mg/L		0.113
Total Manganese (Mn)	mg/L		0.309
Total Molybdenum (Mo)	mg/L		<0.0010
Total Nickel (Ni)	mg/L	Max avg (0.5 mg/L) Max grab (1.0 mg/L)	0.0025
Total Selenium (Se)	mg/L		<0.00010
Total Silver (Ag)	mg/L		<0.000020
Total Strontium (Sr)	mg/L		2.41
Total Thallium (Tl)	mg/L		0.000026
Total Tin (Sn)	mg/L		<0.0050
Total Titanium (Ti)	mg/L		<0.0050
Total Uranium (U)	mg/L		0.00011
Total Vanadium (V)	mg/L		<0.0050
Total Zinc (Zn)	mg/L	Max avg (0.4 mg/L) Max grab (0.8 mg/L)	0.0054
Total Calcium (Ca)	mg/L		126
Total Magnesium (Mg)	mg/L		20.8
Total Potassium (K)	mg/L		10.8
Total Sodium (Na)	mg/L		104
BTEX & F1 Hydrocarbons			
Benzene	ug/L		<0.20

Post treatment EWTP

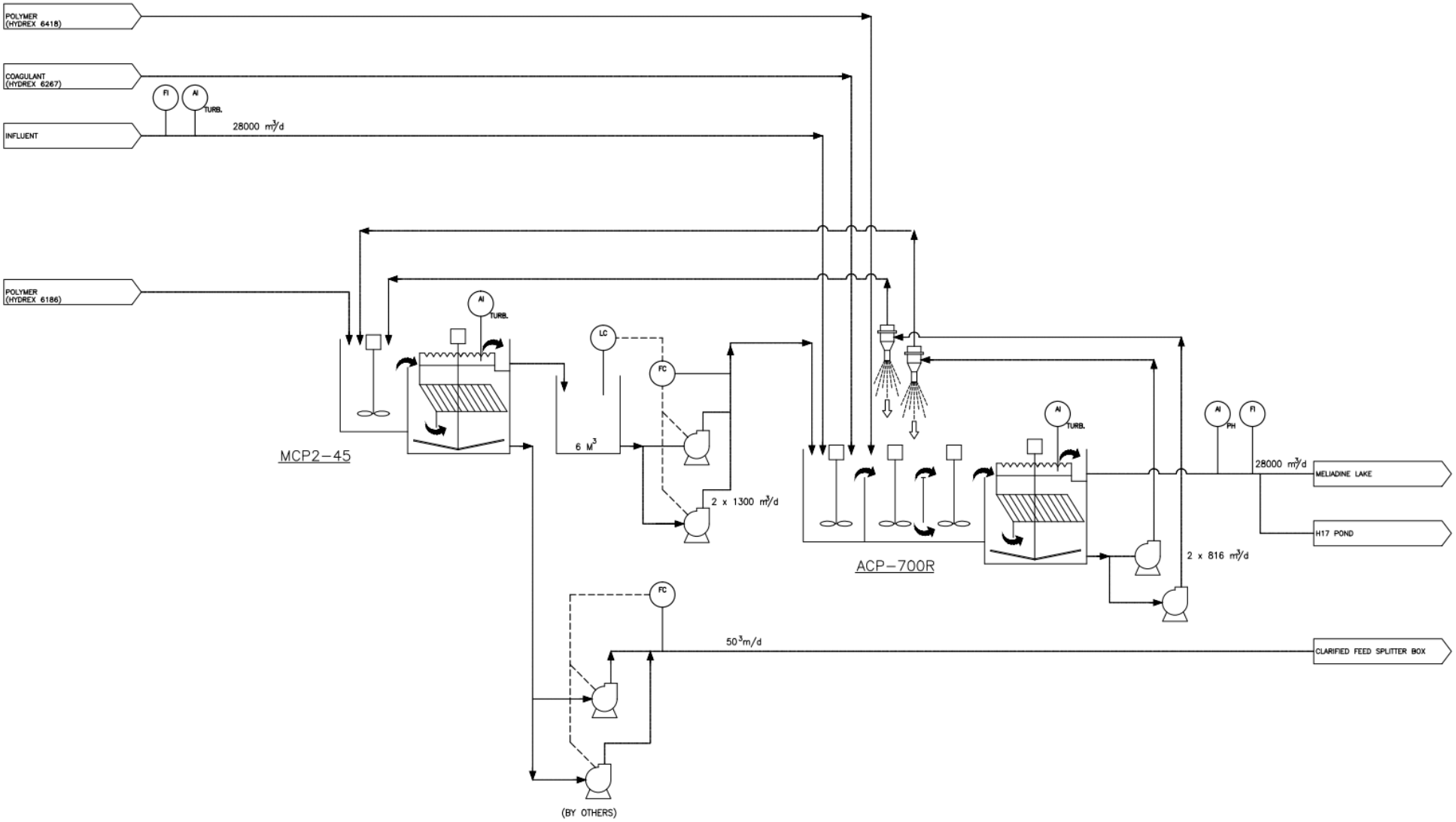
Date		**License A 2AM-MEL1631 Part F, Item 3**	**1-Jul-18**
field pH			7.35
field cond.			1510 uS
field temp			10.4
Water Bodie: EWTP-POST TREATMENT (MEL-14)			**2018**
Year			
Date sampled			1-Jul-18
Lab Reference			B8G4482
LAB			Maxxam
Parameters	**Units**		
Toluene	ug/L		0.32
Ethylbenzene	ug/L		<0.20
o-Xylene	ug/L		<0.20
p+m-Xylene	ug/L		<0.40
Total Xylenes	ug/L		<0.40
F1 (C6-C10)	ug/L		<25
F1 (C6-C10) - BTEX	ug/L		<25
Hydrocarbons (L) (Fraction F1 (C6-C10))	µg/L		
Hydrocarbons (L) (Fraction F2 - F4))		TPH : 5 mg/L avg and grab	
F2 (C10-C16 Hydrocarbons)	µg/L		<100
F3 (C16-34 Hydrocarbons)	µg/L		<200
F4 (C34-50 Hydrocarbons)	µg/L		<200
Reached Baseline at C50	µg/L		Yes
Diesel (C10-C24)	µg/L		
Diesel (C11-C32)	µg/L		
F4G-sg (Grav. Heavy Hydrocarbons)	ug/L		
1,4-Difluorobenzene	%		115
4-Bromofluorobenzene	%		104
D10-Ethylbenzene	%		107
D4-1,2-Dichloroethane	%		115
o-Terphenyl	%		100
Dissolved Hardness	mg/L		398
Dissolved Aluminium (Al)	mg/L		0.0174
Dissolved Antimony (Sb)	mg/L		<0.00050
Dissolved Arsenic (As)	mg/L		0.00088
Dissolved Barium (Ba)	mg/L		0.0977
Dissolved Beryllium (Be)	mg/L		<0.00010
Dissolved Boron (B)	mg/L		0.101
Dissolved Cadmium (Cd)	mg/L		0.000021
Dissolved Chromium (Cr)	mg/L		<0.0010
Dissolved Copper (Cu)	mg/L		0.00099

Post treatment EWTP

Date		**License A 2AM-MEL1631 Part F, Item 3**	**1-Jul-18**
field pH			7.35
field cond.			1510 uS
field temp			10.4
Water Bodie: EWTP-POST TREATMENT (MEL-14)			**2018**
Year			
Date sampled			1-Jul-18
Lab Reference			B8G4482
LAB			Maxxam
Parameters	**Units**		
Dissolved Iron (Fe)	mg/L		0.028
Dissolved Lead (Pb)	mg/L		<0.00020
Dissolved Lithium (Li)	mg/L		0.113
Dissolved Manganese (Mn)	mg/L		0.302
Dissolved Molybdenum (Mo)	mg/L		<0.0010
Dissolved Nickel (Ni)	mg/L		0.0022
Dissolved Selenium (Se)	mg/L		<0.00010
Dissolved Silver (Ag)	mg/L		<0.000020
Dissolved Strontium (Sr)	mg/L		2.44
Dissolved thallium (Tl)	mg/L		0.000027
Dissolved Tin (Sn)	mg/L		<0.0050
Dissolved titanium (Ti)	mg/L		<0.0050
Dissolved Uranium (U)	mg/L		<0.00010
Dissolved Vanadium	mg/L		<0.0050
Dissolved Zinc	mg/L		0.0068
Dissolved Calcium (Ca)	mg/L		125
Dissolved Magnesium (Mg)	mg/L		21
Dissolved Potassium (K)	mg/L		10.9
Dissolved Sodium (Na)	mg/L		101
Dissolved Sulphur (S)	mg/L		
Reactive Silica (Si)	mg/L		0.28
Cobalt (Co)	mg/L		
Cobalt (Co)	mg/L		
Daphina Toxicity	**U.T (Toxic Units)**	TPH : 5 mg/L avg and grab	
Rainbow Trout Toxicity	**U.T (Toxic Units)**	TPH : 5 mg/L avg and grab	

APPENDIX F

Meliadine EWTP Overall Process Flow Diagram



Meliadine EWTP Overall Process Flow Diagram

APPENDIX G

Pipeline Pre-insulated Pipe Specification

MODEL SPECIFICATION
FOR
SCLAIRPIPE® HIGH DENSITY POLYETHYLENE PIPE

1. PIPE & FITTINGS SPECIFICATIONS

1.1 Reference Specifications

ASTM	*D638*	*Standard Test for Tensile Properties of Plastics*
	D792	*Standard Test Methods for Density and Specific Gravity of Plastics by Displacement*
	D1238	*Flow Rates of Thermoplastics by Extrusion Plastomer*
	D1598	*Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure*
	D1599	*Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.*
	D1693	*Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*
	D2290	*Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method*
	D2837	*Standard Test Method for Obtaining Hydrostatic Design Basis for thermoplastic Pipe Materials*
	D3350	*Standard Specification for Polyethylene Plastic Pipe and Fittings Materials*
	F714	*Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter*
	F2164	*Standard Practice for Field Leak Testing of Polyethylene(PE) Pressure Piping Systems Using Hydrostatic Pressure*
	F2620	*Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*
AWWA	*C906*	*Polyethylene Pressure Pipe and Fittings, 4" Through 63" for Water Distribution*
ISO	*9001-2008*	*Quality Systems, Model for Quality Assurance in Production and Installation*

1.2 Material

1.2.1 The resin compound shall be qualified to meet the following:

The pipe shall be made from materials meeting the designations of PE3608 or PE4710 as assigned by the Plastics Pipe Institute.

The pipe shall be made from a polyethylene resin compound with a minimum cell classification of 344464C for PE3608 and 445474C for PE4710 as defined in ASTM D3350.

The Hydrostatic Design Stress (HDS) at 23℃ (73.4℉) shall be 800 psi for resin designated by PE3608 and 1,000 psi for resin designated by PE4710 (PPI TR-4 , Table 1.A.8 for PE3608, Table 1.A.13 for PE4710).

1.2.2 The pipe material shall contain 2% - 2 ½% well dispersed carbon black. Additives which can be conclusively proven not to be detrimental to the pipe may also be used, provided the pipe produced meets the requirements of this specification.

1.2.3 The pipe shall contain no recycled compound except that which is generated in the manufacturer's own plant, from resin of the same specification and from the same raw material supplier.

1.2.4 The pipe supplier shall certify compliance with the requirements of this section in writing.

1.3 Pipe Design

1.3.1 The pipe shall be designed in accordance with the relationships of the ISO modified formula as stated in ASTM F714.

1.3.2 The design pressure rating shall be derived using an HDS of 800 psi at 23℃ (73.4℉) for a PE3608 designation and an HDS of 1,000 psi at 23℃ (73.4℉) for a PE 4710 designation, resulting in the following maximum continuous Working Pressure Rating (WPR, psi) for the respective pipe classes:

	DR32.5	DR26	DR21	DR17	DR15.5	DR13.5	DR11	DR9	DR7.3	DR6.3
PE3608	50	64	80	100	110	128	160	200	254	300
PE4710	63	80	100	125	138	160	200	250	317	379

1.3.3 Overpressure limits for pipe shall be allowed a specific magnitude greater than the maximum continuous working pressure of the pipe. Simple guidelines for frequent and infrequent surge conditions are as follows:

i) Frequent surge pressures shall be permitted where the magnitude of the total pressure is not greater than 150% of the maximum allowable continuous working pressure of the pipe. Frequent surge pressures are typically generated by normal pump flow changes and valve operations.

ii) Infrequent surge pressures shall be permitted where the magnitude of the total pressure is not greater than 200% of the maximum allowable continuous working pressure of the pipe. Infrequent surge pressures are described as pump power-out shut down or quick emergency valve closures.

1.4 Fittings

1.4.1 HDPE pipe flange assemblies shall meet the following requirements unless otherwise specified by the engineer:

i) Solid HDPE stub ends or flange adapters shall be made from the same resin grade (PE3608 or PE4710) and shall be formed using extrusion or molding methods.

ii) Flange rings shall be ductile iron (ASTM A536-84) made to Class 150, ANSI B16.1/B16.5 dimensional standards with exceptions.

iii) Methods for flange assembly, gasket selection and bolt torque application shall be as outlined in PPI Technical Note TN-38.

2. QUALITY ASSURANCE

2.1 General Requirements

2.1.1 The general quality assurance practices and methods shall be in accordance with ISO 9001-2008 or equivalent quality management program.

2.1.2 The customer or engineer shall be allowed free access to the manufacturer's plant facilities to audit, witness and inspect the methods, practices, tests and procedures of the quality assurance program.

2.2 Incoming Material Inspection

2.2.1 All incoming materials shall be inspected and tested by the pipe manufacturer for verification of the resin supplier's adherence to the material specification. The test shall include:

i) Density ASTM D792
ii) Melt Flow Rate ASTM D1238
iii) Thermal Stability (DSC) ASTM D3350

2.2.2 In Addition, the resin supplier shall provide certification of the following physical properties with each lot shipment of material:

i) Density ASTM D792
ii) Melt Flow Rate ASTM D1238
iii) Tensile Strength ASTM D638
iv) Elongation ASTM D638
v) E.S.C.R. ASTM D1693 Condition C
vi) Thermal Stability, DSC ASTM D3350

2.3 Finished Goods Evaluation

2.3.1 The following shall be checked or verified on a daily and controlled basis:

i) Pipe dimensions and tolerances as per ASTM F714
ii) Pipe workmanship as per ASTM F714
iii) Pipe attributes of density and melt flow rate
iv) Reverse bend and DSC testing
v) Carbon black content

2.3.2 In addition to the above, pipe physical test requirements shall be verified on a periodic basis with the emphasis of accumulating data to demonstrate conformance for each respective pipe size range to ASTM F714. Test reports shall be submitted for review to the engineer to qualify a manufacturer for conformance purposes. This report shall include as a minimum the following:

Test data dating over one year covering the following production per plant location:

i) Two pipe sizes manufactured in each of the three size ranges: 4" to 12" (100 to 300mm), greater than 12" to 24" (300 to 600mm), and greater than 24" (600mm) shall be tested by elevated temperature sustained pressure test as per Table 3 in ASTM F714, for each polyethylene resin used.

ii) Two pipe sizes manufactured in each of the three size ranges: 4" to 12" (100 to 300mm), greater than 12" to 24" (300 to 600mm), and greater than 24" (600mm) shall be tested for tensile properties. One of the following tests may be used to verify pipe tensile properties:

- Tensile Test as per ASTM D638
- Apparent Tensile Test as per ASTM D2290

2.3.3 Additional tests to be performed to meet the requirements of AWWA C906 shall be as follows (minimum once per year):

i) Apparent ring tensile test as per ASTM D2290
or
Quick burst hydrostatic pressure test as per ASTM D1599

ii) Elevated temperature sustained pressure test as per ASTM D1598 at 80℃
or
Short term 5 second hydrostatic pressure test at four times the working pressure rating

3. MARKING AND SHIPPING

3.1 Marking

3.1.1 The pipe shall be clearly marked using an inkjet printing method such that the marking is visible, legible and permanent.

3.1.2 The marking shall include the following and shall be applied so as to repeat this information at least once in every 5 feet:

i) Name or trademark of manufacturer (i.e. KWH SCLAIRPIPE)

ii) Nominal pipe size (i.e. 14" IPS or 400mm)

iii) Pipe rating (DR 17)

iv) Standard material code designation (i.e. PE3608 or PE4710)

v) Appropriate Manufacturing Standard (i.e. ASTM F714 or AWWA C906)

vi) Production code which describes the resin compound, manufacturing location, year, month and day

Additional markings may be required by the purchaser and shall be added to the markings on the pipe.

3.2 Shipping

Unless otherwise specified by the purchaser, all pipe and fittings shall be prepared for standard commercial shipment. Care shall be taken to prevent cuts, scratches and other damage.

Unless specifically requested by the customer in writing, pipe shipments shall not be nested.

4. CONSTRUCTION PRACTICES

4.1 Inspection of Materials

4.1.1 The customer shall inspect all pipe and accessories for shortages, loss or damage upon receipt of the shipped material at the time of unloading, recording this information directly on the waybill received from the carrier.

4.1.2 Acceptable limits for cuts, gouges or scratches are as follows:

i) Pipe outer surface shall not be cut, scratched or gouged to a depth greater than 10% of the pipe minimum wall thickness.

ii) Pipe internal surface shall be free of all cuts, gouges or scratches.

4.2 Handling and Storage

4.2.1 Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe.

4.2.2 Stacked pipe shall be stored in accordance with manufacturer's recommendations to minimize pipe ovalization.

4.2.3 Pipe shall be handled using suitable slings or lifting equipment. Also, pipe shall not be dragged over sharp objects or surfaces.

4.3 Thermal Butt Fusion

4.3.1 Butt fusion joining of pipe and fittings shall be performed in accordance with the procedures outlined in the manufacturer's 'butt fusion procedures' requirements which are based upon PPI's 'Generic Butt Fusion Procedures' as set out in PPI's TR-33 and as described in ASTM F2620.

4.3.2 Fusion technicians that have been trained in the use of the appropriate procedures (see 4.1.6) and evaluated by fusion equipment manufacturers, must conduct the butt fusion joining.

4.3.3 Butt fusion shall be performed using suitable machinery.

6. TESTING

The intent of leak testing is to find unacceptable faults in a piping system. Leakage tests may be performed if required by the Contract Specifications.

5.1 Pressure Testing Precautions

5.1.1 The pipe system under test and any closures in the test section should be restrained against any unanticipated separation during pressurization. Refer to ASTM F2164. .

5.1.2 Test equipment should be examined before pressure is applied to ensure that it is tightly connected. All low pressure filling lines and other items not subject to the test pressure should be disconnected or isolated.

5.1.3 Testing may be conducted on the system, or in sections. The limiting test section size is determined by test equipment capability. If the pressurization equipment is too small, it may not be possible to complete the test within allowable testing time limits. If so, higher capacity test equipment or a smaller test section may be necessary.

5.1.4 If possible, test medium and test section water temperatures should not exceed 80° F (27° C). At temperatures above this level, reduced test pressure is required. Before applying test pressure, time may be required for the test medium and test pipe section to temperature equalize.

5.2 Test Procedure

5.2.1 For a test pressure that is 1.5 times the system design pressure, the total test time including initial pressurization, initial expansion, and the time at the test pressure, must not exceed eight (8) hours[1].

5.2.2 Hydrostatic pressure testing should be done in accordance with ASTM F2164. Clean water is strongly recommended as the test medium. The test section should be completely filled with water, taking care to bleed off any trapped air. Venting at high points may be required to purge air pockets while the test

[1] For test durations longer than 8 hours, the test pressure should be reduced. Refer to PPI Engineering Handbook, Chapter 2 for test methods.

sections are filling. Venting may be provided by loosening flanges or by using equipment vents. Retighten loosened flanges before applying test pressures.

5.2.3 Pressurize the pipe up to the desired test pressure. The test procedure consists of initial expansion, and test phases. For the initial expansion phase, the test section is pressurized to test pressure and make-up test liquid is added as required to maintain maximum test pressure for four (4) hours. For the test phase, the test pressure is reduced by 10 psi. This is the target test pressure. If the pressure remains steady (within 5% of the target test pressure) for an hour, leakage is not indicated.

5.2.4 If leaks are discovered, depressurize the test section before repairing leaks. Correctly made fusion joints do not leak. Leakage at a butt fusion joint may indicate imminent pressurized rupture. Depressurize the test section immediately if butt fusion leakage is discovered. Leaks at fusion joints require the fusion joint to be cut out and redone.

5.2.5 If the pressure leak test is not completed due to leakage, equipment failure, etc., the test section should be de-pressurized and repairs made. Allow the test section to remain depressurized for at least eight (8) hours before retesting.

APPENDIX H
Pipe Fusion Manual

TETRA TECH

Table of Contents

This manual contains accurate and reliable information to the best of our knowledge as of the publication date. The results of using our suggestions and recommendations cannot be guaranteed because the conditions of use are beyond our control. Failure to follow these procedures in this manual may result in damage to or destruction of property and/or serious injury to or death of a person. The user of such information assumes all risk connected with the use thereof. ISCO Industries, LLC assumes no responsibility for the use of information presented herein and hereby disclaims all liability in regard to such use.

Fusion Equipment Safety Information

Fusion Equipment Safety Information

Safety Alerts

This hazard alert sign ⚠ appears in this manual. When you see this sign, carefully read what it says. YOUR SAFETY IS AT STAKE.

You will see the hazard alert sign with these words: DANGER, WARNING, and CAUTION.

⚠ DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

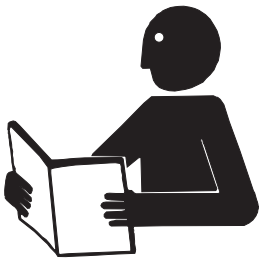
In this manual you should look for two other words: NOTICE and IMPORTANT.

NOTICE:
Can keep you from doing something that might damage the machine or someone's property. It may also be used to alert against unsafe practices.

IMPORTANT:
Can help you do a better job or make your job easier in some way.

Read And Understand

Do not operate fusion equipment until you have carefully read, and understand the "Safety" and "Operation" sections of this manual, and all other equipment manuals that will be used with it.



Your safety and the safety of others depends upon care and judgement in the operation of this equipment.

Follow all applicable federal, state, local, and industry specific regulations.

Fusion Equipment Safety Information

ISCO Industries, LLC cannot anticipate every possible circumstance that may involve a potential hazard. The warnings in this manual and on the machine are therefore not all inclusive. You must satisfy yourself that a procedure, tool, work method, or operating technique is safe for you and others. You should also ensure that the machine will not be damaged or made unsafe by the method of operation or maintenance you choose.

General Safety
Safety is important. Report anything unusual that you notice during set up or operation.

Listen for thumps, bumps, rattles, squeals, air leaks, or unusual sounds.

Smell odors like burning insulation, hot metal, burning rubber, hot oil, or natural gas.

Sense any changes in the way the equipment operates.

See problems with wiring and cables, hydraulic connections, or other equipment.

Report anything you see, feel, smell, or hear that is different from what you expect, or that you think may be unsafe.

Wear Safety Equipment
Wear a hard hat, safety shoes, safety glasses, and other applicable personal protection equipment.

Remove jewelry and rings, and do not wear loose-fitting clothing or long hair that could catch on controls or moving machinery.

Fusion Equipment Safety Information

Units With Hydraulics

Although the hydraulic pressures in the machine are low compared to some hydraulically operated equipment, it is important to remember that a sudden hydraulic leak can cause serious injury or even be fatal if the pressure is high enough.

⚠WARNING Escaping fluid under pressure can penetrate the skin causing serious injury. Keep hands and body away from pinholes which eject fluid under pressure. Use a piece of cardboard or paper to search for leaks. If any fluid is injected into the skin, it must be immediately removed by a doctor familiar with this type of injury.

NOTICE:
Wear safety glasses, and keep face clear of area when bleeding air from hydraulic system to avoid spraying into eyes.

Heaters Are Not Explosion Proof

⚠ DANGER Heaters are not explosion proof. Operation of a heater in a hazardous environment without necessary safety precautions will result in explosion and death. When operating in a hazardous environment, heater should be brought up to temperature in a safe environment, then unplugged before entering the hazardous atmosphere for fusion.

Fusion Equipment Safety Information

Electric Motors Are Not Explosion Proof

⚠ DANGER Electric Motors are not explosion proof. Operation of these components in a hazardous environment without necessary safety precautions will result in explosion or death. When operating in a hazardous environment, keep pump motor and chassis in a safe area by using hydraulic extension hoses.

Electrical Safety

⚠WARNING Always ensure power cords are properly grounded. It is important to remember that when you are working in a wet environment with electrical devices, proper ground connections help to minimize the chances of an electric shock.

Frequently inspect electrical cords and unit for damage. Damaged components need to replaced and service performed by a qualified electrician. Do not carry electrical devices by the cord.

NOTICE:
Always connect units to the proper power source as listed on the unit, or in the owner's manual. On units with two power cords, plug each cord into separate power circuits. Do not plug into both outlets of one duplex receptacle.

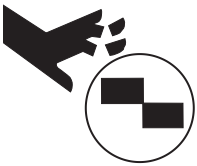
NOTICE:
Disconnect the machine from the power source before attempting any maintenance or adjustment.

Fusion Equipment Safety Information

Crush Points

WARNING Hydraulically operated jaws are operated under pressure. Anything caught in the jaws will be crushed. Keep fingers, feet, arms, legs, and head out of the jaw area. Always check pipe alignment with a pencil or similar object.

Facer Blades Are Sharp



WARNING Facer blades are sharp and can cut. Never attempt to remove shavings while the facer is running, or is in the facing position between the jaws. Use care when operating the facer, and handling the unit.

NOTICE:
Disconnect power from the facer, and remove the facer blades before attempting any maintenance or adjustment.

Heater Is Hot

CAUTION The heater is hot and will burn clothing and skin. Keep the heater in its insulated heater stand or sling blanket when not in use, and use care when heating the pipe.

NOTICE:
Use only a clean non-synthetic cloth such as a cotton cloth to clean the heater plates.

Fusion Procedures

CAUTION Follow the procedures carefully, and adhere to all specified parameters.
Failure to follow procedures could result in a bad weld. Always follow the proper fusion procedures.

Fusion Equipment Safety Information

Units With Gas Engines

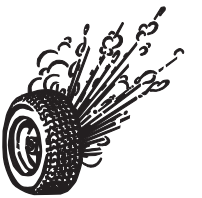
WARNING Handle fuel with care. Fuel is highly flammable. Do not refuel the machine while smoking or near open flames or sparks. Always stop the engine before refueling machine. Fill fuel tank outdoors. Help prevent fires by keeping machine clean of accumulated trash, grease, debris, and facer shavings. Always clean up spilled fuel.

WARNING Breathing exhaust gases can cause sickness or death. Always operate machine outdoors in an area with adequate ventilation.

Units With Batteries

CAUTION Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes. Avoid contact with eyes, skin, and clothing. Exploding gases from battery could cause blindness or serious injury. Keep sparks, flames, and cigarettes away.

Have Tires Properly Serviced



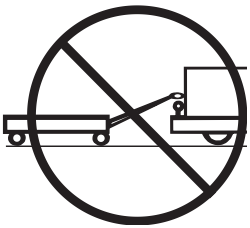
WARNING Failure to follow proper procedures when mounting a tire on a wheel or rim can produce an explosion which may result in serious injury or death. Have tires mounted by someone that is experienced, and has the equipment to perform the job safely.

Fusion Equipment Safety Information

Periodically Check Temperature

NOTICE:
Incorrect heating temperature can result in bad fusion joints. Check heater plate surface temperature periodically with a pyrometer, and make necessary adjustments. The thermometer on heaters indicates internal temperature, and should be used as a reference only.

Do Not Tow Fusion Machine At Speeds Greater Than 8 KM (5 MPH)

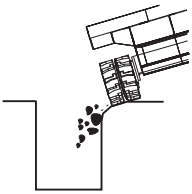


WARNING The chassis is not designed for over-road towing. Towing at speeds greater than five miles per hour can result in machine damage as well as injury. Always transport the machine by flat bed truck or similar means, and make sure that unit is properly secured.

Positioning Fusion Machine

Place fusion machine on as level ground as possible, and set the brake on the rear wheel. If it is necessary to operate machine on unlevel grade, chock the wheels and block the unit to make it as stable as possible.

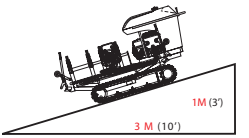
Keep Machine Away From Edge Of Ditch



WARNING Heavy equipment too close to a ditch can cause the walls of the ditch to cave-in. Keep the machine far enough away from the edge of the ditch to prevent injury to personnel and equipment from a cave-in.

Fusion Equipment Safety Information

Operating TracStar Fusion Machines



Place fusion machine on as level ground as possible.

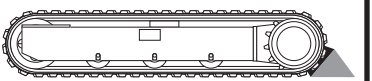
If it is necessary to operate machine on unlevel grade, make sure that the ground is stable. Some unstable conditions maybe ice, snow, mud, and loose gravel.

WARNING For operation safety, never operate machine on a grade steeper than 30%. A 1 M (3') elevation change in 3 M (10').

Do Not Attempt to Tow A TracStar Fusion Machine

CAUTION The machine is not designed for towing. Attempting to tow the machine can result in machine damage. Always transport the machine by flat bed truck or similar means, and make sure that unit is properly secured.

Positioning Fusion Machine



Place fusion machine on as level ground as possible. If it is necessary to operate machine on unlevel grade, chock the tracks and block the unit to make it as stable as possible.

Hearing Protection Required For TracStar 412 and TracStar 618.

When operating machine for more than four hours per day, wear hearing protection.

Fusion Equipment Safety Information

Safety Precautions For Guarding Against Static Electricity And Gaseous Ignition

⚠ DANGER Polyethylene plastic pipe does not readily conduct electricity. A static electricity charge can buildup on inside and outside surfaces and stay on the pipe surface until some grounding device, such as a tool or a person comes close enough for the static electricity to discharge to the grounding device.

⚠WARNING Discharging one part of the pipe surface will not affect other charged areas because static electricity does not flow readily from one area to another. Polyethylene pipe cannot be discharged by attaching grounding wires to the pipe.

Heaters, electric facers and electric power tools are NOT explosion proof. Static electricity discharge can ignite a flammable gas or combustible dust atmosphere.

A static electricity discharge to a person, a tool, or a grounded object close to the pipe surface can cause an electric shock or a spark that can ignite a flammable gas or combustible dust atmosphere causing fire or explosion.

In gas utility applications, static electricity can be a potential safety hazard. Where a flammable gas-air mixture may be encountered and static charges may be present, such as when repairing a leak, squeezing-off an open pipe, purging, making a connection, etc., arc preventing safety precautions are necessary. Observe all procedures for static electricity safety and control, including procedures for discharging static electricity and requirements for personal protection.

Take steps to discharge static electricity from the surface of the polyethylene gas pipe. Such steps include wetting the entire exposed pipe surface with a conductive anti-static liquid or a dilute soap and water solution, then covering or wrapping the entire wetted, exposed pipe surface with grounded wet burlap, conductive poly film, or wet tape conductor. The external covering should be kept wet by occasional re-wetting with anti-static solution. The covering or tape should be suitably grounded such as to a metal pin driven into the ground.

Steps that discharge the outer surface do not discharge the inner surface of the pipe. Squeeze-off purging, venting, cutting, etc., can still result in a static electricity discharge. When appropriate, ground tools and remove all potential sources of ignition.

Fusion Equipment Safety Information

Safety Precautions For Guarding Against Static Electricity And Gaseous Ignition (Continued)

Key items:

Do not put a butt fusion machine chassis in a hazardous environment. Set the chassis up out of harms way and use extension hoses to operate upper works in hazardous area.

Do not use a butt fusion machine with an electric facer in a gaseous environment. Use a machine equipped with a hydraulic facer or convert the electric facer to a manual by removing the brushes and turning facer manually.

When making butt fusions, saddle fusions and socket fusions in a hazardous environment, set the generator up out of harms way and have the heater plugged into it there. Set the heater temperature at the maximum allowed for the application. Use 232° C (450° F) for butt fusion and 266°C (510° F) for saddle fusion and socket fusion. These are surface temperatures. The high side temperatures are used to compensate for the drop in temperature experienced when heater is unplugged from the power source to make fusion in hazardous area. Unplug heater prior to using in a hazardous environment.

Do not drill hole first prior to making a saddle fusion.

When prepping the main pipe for a saddle fusion, **do not** use an electric grinding tool. Prepare main pipe manually by use of 50-60 grit utility cloth.

Do not use an electric drill for punching hole through after saddle fusion has been made.

Use your senses and good judgment: Listen, Smell, Feel, See and Report any unsafe situations you see or see coming to your onsite contact, if corrective action is not taken in your opinion, **Do not** enter into the situation.

Tips For Success

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Tips for Success

- Use Personal Safety Equipment. Always wear a hard hat and protective boots. Gloves protect hands from heater burns and sharp blades on the facer. Protective Eye Glasses are also a good idea.
- Make sure all equipment is in good working order and power cords are free of cuts with grounding blade on receptacle in tack.
- Position fusion equipment on level ground whenever possible.
- If the fusion equipment has wheels, set the wheel lock or block them.
- Position pipe support stands on either side of the fusion equipment approximately 6 M (20') from ends of the fusion equipment. Adjust stands so that pipes are level to reduce drag.
- When working with McElroy Self-Contained fusion units excluding the T-500 and T-900, make sure to open the facer valve prior to starting the unit and keep it open until started. Close valve once unit is running. This will save the battery and keep you from burning up the starter.
- Plug heater in on self-contained fusion units only after unit has been started and warmed up. Unplug heater before turning fusion unit off. This will keep you from having heater element and circuitry problems with your heater.
- Load loose pipe joints into movable side of the fusion equipment and pull joints already fused through non-movable side.
- Check your pipe before you fuse it. Look for deep scratches, cuts and gouges. Use the 10 percent rule: Any imperfection affecting more than 10 percent of the pipe wall being worked with should not be used.
- When rough cutting pipe, use a pipe wrap to mark the pipe with a reference line, this will aid you in making a square and even cut. In general, tooling that works with wood works well with HDPE pipe. For cutting pipe, skill saws and chain saws work well. When using chain saws, the cut ends MUST be cleaned with isopropyl alcohol to remove BAR Oil Splash or any other contaminants. For cutting holes in pipe, drills with hole saws and reciprocating saws work well.
- When making fusions that involve pipe to fittings, special care should be taken. The necking down or toe in at the pipe ends, which is normal, needs to be completely removed in the facing process. This is seen primarily in working with the larger pipe diameters.
- Do not abuse the facer when facing pipes by using too much pressure.
- When pulling pipe through the fusion equipment, elevate pipe in the machine using the pipe lifts so the fusion bead clears all obstructions as it is pulled through.

Tips for Success (Continued)

- If a fusion weld does not come out exactly as you like or you question the quality of the fusion weld, then cut it out and re-fuse. Always remember – IF IN DOUBT, CUT IT OUT and redo.
- Fusion beads can be removed by means of external and internal bead removers without effecting the integrity of the fusion joint.
- In inclement weather and especially in windy conditions, the fusion operation should be shielded to avoid precipitation or blowing snow and excessive heat loss from wind chill. Capping ends of pipe that are being fused aides heater from being chilled as fusion joint is being made.
- The joint area and its parts that are being fused must be completely dry. No liquid of any kind running through the pipe or fittings is permissible.
- When fusion is done in cold weather, DO NOT INCREASE HEATING TOOL SURFACE TEMPERATURE.
- Do not try to shorten cooling times of fusions by applying wet cloths, water or the like.
- When removing pipe from the fusing unit and pulling into place, use proper lifting slings and pulling heads in good condition. Chains and rope can slip and cause injury/damage to personnel and pipe.
- When working with coiled pipe 63 mm-160 mm (2" - 6"), a McElroy LineTamer™ should be used to straighten and reround coiled pipe to meet or exceed ASTM D-2513 Quality Requirements.
- Squeeze tools can be used on HDPE Pipe to stop flow in a pipeline while a tie in or repair is made. Follow manufacturer's squeeze-off tool instructions.
- A common obstacle when working with HDPE pipe in the field is understanding the thermal expansion and contraction.
  Rule of thumb - 2 cm/10 M/10°C (1.4"/ 100'/ 10°F.)

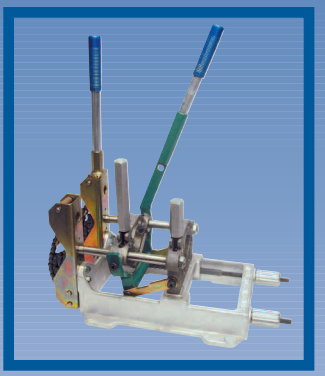
Butt Fusion Joining Rates

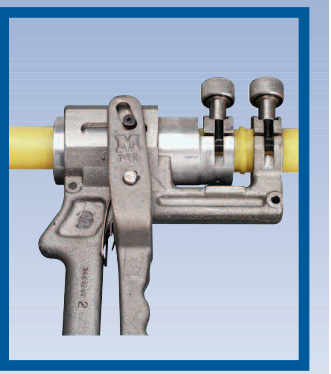
Pipe Sizes IPS/DIPS	Approx. Fusions per 8-10 Hr. Day
20 mm - 90 mm (3/4" - 3")	30 - 60
110 mm - 200 mm (4" - 8")	24 - 48
250 mm - 450 mm (10" - 18")	12 - 24
500 mm - 630 mm (20" - 24")	10 - 16
710 mm- 800 mm (28" - 31.5")	8 - 12
900 mm- 1200mm (36" - 48")	6 - 10
1400 mm - 1600mm (55" - 63")	4 - 8

Important:

Fusions per day are dependent upon pipe wall thickness, equipment to move and handle pipe, manpower, site conditions and weather. Use lower number for estimation and planning.

Manual Butt Fusion Machine Procedure





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Manual Butt Fusion Machine Procedure

The principle of heat fusion is to heat two surfaces to a designated temperature, and then fuse them together by application of force. This pressure causes flow of the melted materials, which causes mixing and thus fusion. When the polyethylene material is heated, the molecular structure is transformed from a crystalline state into an amorphous condition. When fusion pressure is applied, the molecules from each polyethylene part mix. As the joint cools, the molecules return to their crystalline form, the original interfaces are gone, and the two pipes become one homogeneous unit.

The principle operations include:

Cleaning	The pipe ends must be clean and free of any dirt, debris or other contaminants
Clamping	The pipe pieces held axially to allow all subsequent operations to take place.
Facing	The pipe ends must be faced to establish clean, parallel mating surfaces perpendicular to the centerline of the pipes.
Alignment	The pipe ends must be aligned with each other to minimize mismatch or high-low of the pipe wall.
Heating	A melt pattern that penetrates into the pipe must be formed around both pipe ends.
Joining	The melt patterns must be joined with a specified force. The force must be constant around the interface area.
Holding	The molten joint must be held immobile with a specified force until adequately cooled.

BUTT FUSION OF PIPES AND COMPONENTS WITH DIFFERENT WALL THICKNESSES

When Butt Fusion is used to join pipes and other components together they must have the same outside diameter and the difference between minimum wall thickness dimensions for the two components being joined should not exceed 26%.

Example: You have a pipe or fitting that has a wall thickness of 25 mm (1"). You can weld that pipe to pipes or fittings that have a wall thickness of 20 mm (3/4") min. or 32 mm (1-1/4") max.

Important:

- The pipe line is only as strong as its weakest link.
- The fusion pressure used to join two different wall thicknesses is always that of the thinner.

Manual Butt Fusion Machine Procedure

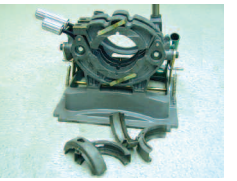
Install Clamping Inserts

Select and install appropriate clamping inserts for the pipe that is being fused.

No. 2LC & No. 2CU machines

20mm - 50mm (1/2" CTS - 2" IPS Pipe) 40 mm (1-1/2") and smaller inserts are fitted to jaw castings using flat head fasteners.

No. 14 Pitbull Machines



32 mm - 110 mm (1" IPS - 4" DIPS Pipe) 2" IPS Master, 90 mm (3") & 110 mm (4") inserts are held in place by spring pins located on upper and lower jaws. 40 mm (1-1/2") and smaller inserts are fitted to 2" IPS Master inserts using flat head fasteners.

Loading Pipe Into Machine
(No. 14 Pitbull Used In the Following Illustrations)

Clean the inside and outside of the pipe ends that are to be fused.

Open the upper jaws and insert pipe in each pair of jaws with applicable inserts installed.

Let the ends of the pipe protrude about 25 mm (1") past the face of the jaws.

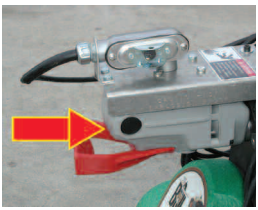
Close upper jaws but do not overtighten.

Manual Butt Fusion Machine Procedure

Electric Facer

The facer is a McElroy Rotating Planer Block Design. The blade holders each contain two cutter blades. The Block rotates on ball bearings and is chain driven (enclosed in lubricant) by a heavy duty electric motor. When operating in a hazardous environment, operate the facer manually.

▲ DANGER Electric motors are not explosion proof. Operation of these components in a hazardous environment will result in explosion and death.



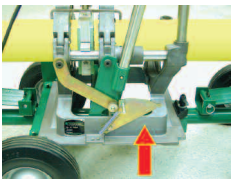
The armature brushes must be removed from the electric motor when manually operating in a hazardous condition. Unscrew the brush covers from both sides of the motor. (Both brushes must be removed). A 22 mm (7/8") hex shaft allows for manual operation in hazardous conditions.

The facer has a handle that latches into place on a guide bar. The handle must be pulled out to unlatch and remove facer.

Manual Facer for No. 2LC and No. 2CU

The manually operated facer has a hand powered crank. Turn the crank counterclockwise for facing.

Cam Lock



A semi-automatic cam locking system locks the movable jaw during the cooling cycle.

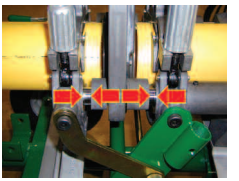
Manual Butt Fusion Machine Procedure

Inserting Facer

Place the end opposite the handle onto the far guide rod, then lower the facer handle end down onto the near guide rod and latch.

Positioning Pipe In Machine

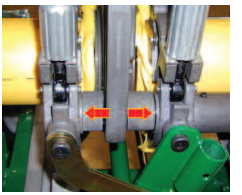
With facer in position use lever handle to bring pipe ends together against the facer, watching the gap between the facer stops and the pipe clamping jaws. Leave enough gap so that proper face-off will be achieved when the facer stops are bottomed out against the clamps. Tighten the pipe clamp knobs by hand until firm resistance is felt. Do not over-tighten.



Important:
Thoroughly clean all dirt and debris from pipe ends before facing.

Facing The Pipe Manually

Turn facer handle counterclockwise and apply firm pressure on lever handle. Continue facing until facer stops have bottomed out against the clamping jaws. Stop rotation of facer. Move jaws apart.



Unlatch and remove facer. Remove shavings from pipe ends and machine. Do not touch faced pipe ends.

Inspect both pipe ends for complete face off. If the face off is incomplete, return to Loading Pipe Into Machine on page 20.

Manual Butt Fusion Machine Procedure

Electric Facer

The electric facer should be started before the pipe is pushed into contact with the blades.

Continue facing until the facer stops are against the jaws.

Turn off the facer while continuing to hold pressure closed on the lever until the facer stops completely.

Reverse force to the lever handle to move the pipe ends away from the facer.

Unlatch and remove the facer taking care not to touch the pipe ends.

Remove shavings from pipe ends and machine.

Do not touch faced pipe ends as this may contaminate them.

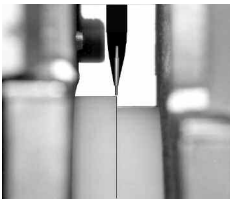
If faced pipe ends are touched, use a clean non-synthetic cloth to clean affected area before proceeding.

If after facing, any imperfections are visible, return to Loading Pipe Into Machine on page 20.

Any time clamp knobs are tightened, pipe ends should be refaced.

Manual Butt Fusion Machine Procedure

Check Alignment Of Pipe



Bring the pipe ends together under sufficient force to overcome any pipe drag or friction in the system.

Check for alignment and proper face off. If high/low (misalignment) exists, adjust by tightening the clamp on the high side and reface the pipes. Their should be no more than 10% of the wall thickness in misalignment to maintain full joint strength.

Notice:
When clamping, do not over-tighten the clamp knobs because machine damage can result. Check to see if there is space between the upper and lower jaws. If the two jaws are touching, do not continue to tighten. Bring the pipe ends together under fusion pressure to check for slippage. If slippage occurs, return to Loading Pipe Into Machine section on page 20.

Check Heater Temperature

CAUTION Incorrect heating temperature can result in questionable fusion joints. Check heater plates periodically in multiple locations with a pyrometer and make necessary adjustments.

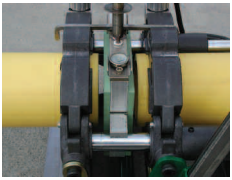
For butt fusion heater surface temperature should be Minimum 205°C (400° F), **Optimum 218°C (425° F)**, Maximum 230°C (450° F).

Important:
The dial thermometer on the heater indicates internal temperature which varies from the actual surface temperature.

The dial thermometer can be used as reference once the surface temperature has been verified.

Manual Butt Fusion Machine Procedure

Inserting Heater



⚠ DANGER Heater Is Not Explosion Proof. Operation of heater in a hazardous environment without necessary safety precautions will result in explosion and death.

If operating in a hazardous environment, heater should be brought up to temperature in a safe environment, then unplugged before entering the hazardous atmosphere for fusion.

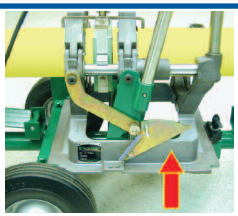
Use a clean non-synthetic cloth to clean butt fusion heater adapter surfaces.

Check heater adapters for coating damage, plastic buildup rings and surface imperfections. These conditions could cause a poor fusion. Replace them if conditions exist.

Verify heater temperature by referencing the reading on the dial thermometer.

Insert heater between the pipe ends. The stripper bar downward legs should be outside of the jaws. (not on top)

Heating The Pipe



With heater in position between the pipe ends, snap pipe ends sharply against the heater to ensure proper seating. Raise the locking cam into the engaged position while in the heating cycle. ***Do not heat under pressure.***

Notice:
The heating of the pipe ends is strictly a manual and visual process that is done with only contact pressure. The time it takes for the melt beads to reach their proper size and heating cycle is dependent on the working environment. The heating cycle is complete when the melt beads are the following sizes depending on the pipe OD.

(See **Approximate Melt Bead Size Chart** on page 26).

Manual Butt Fusion Machine Procedure

Approximate Melt Bead Size (Pipe Ends):

Pipe Size	Approximate Melt Bead
40 mm (1-1/4") and smaller	1mm - 2 mm (1/32" – 1/16")
50 mm (1-1/2") through 90 mm (3")	2 mm - 3 mm (1/16" – 1/8")
110 mm (4")	3 mm - 5 mm (1/8" – 3/16")

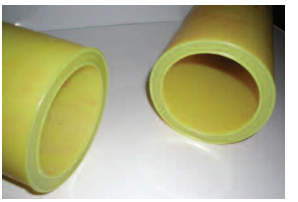
Fusing the Pipe

Once melt beads are of proper size, remove the heater, QUICKLY inspect the melted ends, which should be flat, smooth, and completely melted. If the melted surfaces are acceptable, immediately and in a continuous motion, bring the ends together and apply enough joining force for the beads to touch, flare up and roll back till they come in FULL contact with the pipe surfaces being fused. Do not slam.

A concave melt surface is unacceptable; it indicates pressure during heating. Do not continue. Allow the melted ends to cool and start over.

The locking cams will assist by holding force during the cooling cycle.

Unacceptable Concave Melt Appearance



What Causes This?

Answer - Heating under pressure.

Notice:
A concave melt surface is unacceptable; it indicates pressure during heating. Do not continue. Allow the melted ends to cool and start over.

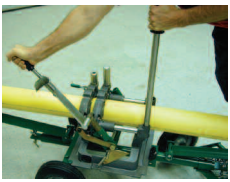
Manual Butt Fusion Machine Procedure

Optional Use Of Torque Wrench

After the heating cycle is completed, remove the heater and quickly apply fusion force with the lever handle. To use a torque wrench with the No. 14 Pitbull, place an adapter in the lever socket.

P/N 410802

The locking cams will assist by holding force during the cooling cycle.



CAUTION Failure to follow the proper heating time, pressure and cooling time may result in a bad joint.

Approximate Values		
Torque Wrench Reading	No. 2LC	No. 14 Pitbull
Nm (Ft.Lb.)	N (Lbs.Force)	N (Lbs. Force)
15 (10)	320 (70)	520 (115)
30 (20)	600 (135)	960 (215)
45 (30)	890 (200)	1470 (330)
60 (40)	1160 (260)	1935 (435)
75 (50)	1425 (320)	2425 (545)
90 (60)	1780 (400)	2935 (660)
105 (70)	2135 (480)	3470 (780)
120 (80)	2450 (550)	4070 (915)
135 (90)	2825 (635)	4560 (1025)
150 (100)	3070 (690)	5070 (1140)

Interfacial Pressure (IFP)
Minimum
4.1 Bar (60 psi)
Optimum
5.2 Bar (75 psi)
Maximum
6.2 Bar (90 psi)

To determine the amount of force required:
(OD-t) x t x 3.1416 x 5.2 Bar (IFP) = Force

This value is then read on chart to determine how much torque is needed to apply the force.

Manual Butt Fusion Machine Procedure

Cooling Of The Fusion Joint

The fusion joint must be kept under pressure until the joint is cool. This time will vary with pipe size, wall thickness, heater temperature setting and environmental conditions.

There are three acceptable methods that can be used individually or combined.

1) Cool to the touch.

2) Timing "Guidelines Only" Chart.

Timing "Guidelines Only" Chart

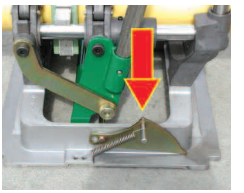
Wall Thickness of Pipe being Fused	Cooling Time 23°C (74 ° F)
Up to 5 mm (0.2")	5 min.
5 mm (0.2") to 10 mm (0.4")	5 to 10 min.
10 mm (0.4") to 15 mm (0.6")	10 to 15 min.
15mm (0.6") to 20 mm (0.8")	15 to 20 min.

3) Use pyrometer to measure temperature of the weld bead and compare it to the temperature of the pipe and or fittings being fused. If the temperatures are the same, the cooling requirement has been met.

Notice: Heavier wall thickness pipes require longer cooling times.

Allow the joint to cool an additional thirty (30) minutes minimum outside of the fusion machine before subjecting the fusion joint to any rough handling or severe bending.

Remove Pipe and Inspect



After pipe has cooled sufficiently, apply closing force on the lever handle and push the locking cams down into the unlocked position. Unscrew the clamp knobs enough that they can be swiveled outward.

Pull pipe through machine, and prepare for making next fusion. Inspect joint and if it has to be redone, use Trouble Shooting Guides to determine problem and make adjustments before next fusion. (See pages 29 and 30)

Manual Butt Fusion Machine Procedure

Butt Fusion Joint Troubleshooting Guide

The Inspection Of The Fusion Joint

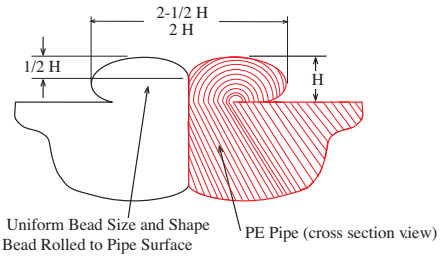
Golden Rule: If in doubt, cut it out and redo.

The double bead should be rolled over onto the adjacent surfaces, and be uniformly rounded and consistent in size all around the joint. As illustrated in the Figure below, the double bead width should be 2 to 2-1/2 times its height above the surface, and the v-groove depth between the beads should not be more than half the bead height.

When butt fusing to molded fittings, the fitting side bead may have an irregular appearance. This is acceptable provided the pipe side bead is correct.

It is not necessary for the internal bead to roll over to the inside surface of the pipe.

Butt Fusion Bead Proportions



Note: This is a "guideline" only and should not be taken solely as pass or fail. The bead may be in various configurations but they must satisfy the following requirements:

- There shall be no evidence of cracks or incomplete fusion.
- Joints shall not be visually mitered (angled, offset). The ovality offset shall be less than 10% of the minimum wall thickness of the fused components.
- The cleavage between fusion beads shall not extend to or below the outside pipe diameter pipe surface.

Manual Butt Fusion Machine Procedure

Butt Fusion Joint Troubleshooting Guide

Observed Condition	Possible Cause
Excessive double bead width	Overheating; Excessive joining force
Double bead v-groove too deep	Excessive joining force; Insufficient heating; Pressure during heating
Flat top on bead	Excessive joining force; Overheating
Non-uniform bead size around pipe	Misalignment; Defective heating tool; Worn equipment; Incomplete facing
One bead larger than the other	Misalignment; Component slipped in clamp; worn equipment; defective heating tool; incomplete facing
Beads too small	Insufficient heating; Insufficient joining force
Bead not rolled over to surface	Shallow v-groove - Insufficient heating & insufficient joining force; Deep v-groove - Insufficient heating & excessive joining force
Beads too large	Excessive heating time
Squarish outer bead edge	Pressure during heating
Rough, sandpaper-like, bubbly, or pockmarked melt bead surface	Hydrocarbon contamination

Hydraulic Butt Fusion Machine Procedure

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Hydraulic Butt Fusion Machine Procedure

The principle of heat fusion is to heat two surfaces to a designated temperature, and then fuse them together by application of force. This pressure causes flow of the melted materials, which causes mixing and thus fusion. When the polyethylene material is heated, the molecular structure is transformed from a crystalline state into an amorphous condition. When fusion pressure is applied, the molecules from each polyethylene part mix. As the joint cools, the molecules return to their crystalline form, the original interfaces are gone, and the two pipes have become one homogeneous unit.

The principle operations include:

Cleaning	The pipe ends must be clean and free of any dirt, debris or other contaminants
Clamping	The pipe pieces held axially to allow all subsequent operations to take place.
Facing	The pipe ends must be faced to establish clean, parallel mating surfaces perpendicular to the centerline of the pipes.
Alignment	The pipe ends must be aligned with each other to minimize mismatch or high-low of the pipe wall.
Heating	A melt pattern that penetrates into the pipe must be formed around both pipe ends.
Joining	The melt patterns must be joined with a specified force. The force must be constant around the interface area.
Holding	The molten joint must be held immobile with a specified force until adequately cooled.

BUTT FUSION OF PIPES AND COMPONENTS WITH DIFFERENT WALL THICKNESSES

When Butt Fusion is used to join pipes and other components together they must have the same outside diameter and the difference between minimum wall thickness dimensions for the two components being joined should not exceed 26%.

Example: You have a pipe or fitting that has a wall thickness of 25 mm (1”). You can weld that pipe to pipes or fittings that have a wall thickness of 20 mm (3/4”) min. or 32 mm (1-1/4”) max.

Important:

- The pipe line is only as strong as its weakest link.
- The fusion pressure used to join two different wall thicknesses is always that of the thinner.

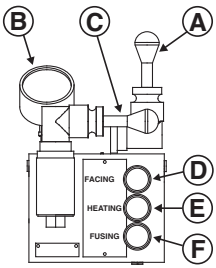
Hydraulic Butt Fusion Machine Procedure

Hydraulic Manifold Block

Mounted on this block are a carriage directional control valve, a selector valve, three pressure reducing valves, and a pressure gauge.

A) The carriage control value, mounted on the top of the manifold, determines whether the carriage is moving left, right, or in neutral.

B) A pressure gauge is mounted on top of the manifold.



C) The selector valve, mounted on the front of the manifold, selects a pressure from one of the pressure reducing valves. Each pressure reducing valve is labeled with a different function.

D) The top valve adjusts facing pressure, normally 3 to 7 Bar (50-100 psi) gauge pressure.

E) The middle valve adjusts heating pressure, always 0 Bar (0 psi) or backed all the way out turning knob counterclockwise. The drag pressure may have to be compensated for when working with more than one joint of pipe on the movable side or with tie-ins.

F) The bottom valve adjusts fusion pressure, this pressure must be determined.

Install Clamping Inserts

Select and install appropriate clamping inserts for the pipe that is being fused.

Hydraulic Butt Fusion Machine Procedure

Check Hydraulic Pressure

The pressure gauge on the manifold block indicates the pressure of the carriage valve. How much pressure depends on the position of the selector valve and the pressure set on the specific pressure reducing valve. With the selector valve up, the facing pressure can be set. It may be necessary to adjust the carriage speed, while facing, with the top pressure-reducing valve to control facing speed.

Shift the selector valve to the center position, heating, and set the pressure reducing valve at its lowest setting, or the drag pressure, whichever is higher.

With the selector valve in the down position, the fusion pressure can be set.

The fusion pressure can be calculated using the Fusion Pressure Calculator (shown on the next page or by using the formula on the next page, or they can be found in the reference section.)

An approximate 2 Bar (30 psi) drag factor should compensate for seal, and pipe drag with one joint of pipe on a pipe stand. If additional lengths of pipe are being moved by the movable jaws, the actual drag pressure should be determined using the following procedure:

After facing the pipe, move the carriage so that the pipe ends are approximately 50 mm (2") apart.

Shift the carriage control valve to the middle (neutral) position, select the heating mode, and adjust the middle pressure reducing valve to its lowest pressure by turning the valve counterclockwise.

Shift the carriage control valve to the left.

Gradually increase the pressure by turning the heating valve clockwise. Increase the pressure until the carriage moves.

Quickly reduce the heating pressure valve counterclockwise until the carriage is just barely moving.

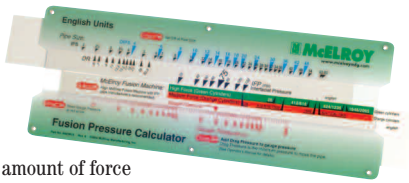
Record this actual drag pressure.

Take the pressure, determined from the Fusion Pressure Calculator, and add the actual measured drag pressure. This will be the actual fusion pressure to set with the bottom pressure reducing valve. If fusion pressures are used from the reference section, you must subtract 2 Bar (30 psi) drag, which is already figured in and then add the actual drag pressure back.

Adjust the middle heating valve to show recorded drag so that pipe ends will stay in contact with heater during heating phase.

Hydraulic Butt Fusion Machine Procedure

Fusion Pressure Calculator



Interfacial Pressure (IFP)
Minimum 4.1 Bar (60 psi)
Optimum 5.2 Bar (75 psi)
Maximum 6.2 Bar (90 psi)

Interfacial Pressure (IFP) = amount of force per sq. inch of the surface area of the pipe end. Interfacial Pressure (IFP) and Fusion machine gauge pressure are not the same.

How to Use the Fusion Pressure Calculator

Step 1: Set DR at Pipe Size.
Step 2: Align McElroy Fusion Machine with IFP.
Step 3: Read Gauge Pressure at red arrow.
Step 4: Add Drag Pressure to gauge pressure.

Determining Fusion Pressure

Variable Definitions
OD = Outside Diameter
t = Wall Thickness
π = 3.1416
DR = Dimensional Ratio
IFP = Recommended Interfacial Pressure (Shown Above)
TEPA = Total Effective Piston Area
DRAG = Force Required to Move Pipe

Example:
Using a McElroy No. 250 Standard Fusion Machine (Low Force, Yellow Cyl.)
OD of Pipe = 200 mm
DR of Pipe = 11
Recommended Interfacial Pressure = 5.2 Bar (75 PSI)
Measured Drag 2 Bar (30 PSI)

Formula: Wall Thickness

$$t = \frac{OD}{DR} = \frac{200\ mm}{11} = 18.2\ mm$$

TEPA = 1077 mm^2 (1.67 in^2) (chosen from the table on page 36)

$$\text{Gauge Pressure} = \frac{(OD - t) \times t \times \pi \times IFP}{TEP\ A} + DRAG$$

$$\text{Gauge Pressure} = \frac{(200 - 18.2) \times 18.2 \times 3.14 \times 5.2}{1077} + 2 = 52\ Bar$$

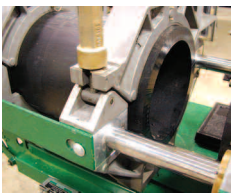
Hydraulic Butt Fusion Machine Procedure

Notice:
See Reference Section, pages 80-85, for fusion pressure charts showing pressures precalculated to include 2 Bar (30 psi) for system drag.

Determining Fusion Pressure (Continued)

	TEPA = Total Effective Piston Area mm^2 (in^2)		
Fusion Machine Model	High Force Standard (Green Cylinders)	Medium Force High Velocity (Orange Cylinders)	Low Force Extra High Velocity (Yellow Cylinders)
250 or T-250	3039 (4.71)	NA	1077 (1.67)
412 or T-412	7600 (11.78)	3877 (6.01)	2026 (3.14)
618 or T-618	7600 (11.78)	3877 (6.01)	2026 (3.14)
T-500 Series I or II	NA	3877 (6.01)	NA
824	19000 (29.44)	9885 (15.32)	6097 (9.45)
1236	19000 (29.44)	9885 (15.32)	6097 (9.45)
T-900	19000 (29.44)	9885 (15.32)	6097 (9.45)
1648	20272 (31.42)	9123 (14.14)	NA
2065	20272 (31.42)	NA	NA

Loading Pipe Into Machine
(No. 412 and No. 618 Used In the Following Illustrations)



Clean the inside and outside of pipe ends that are to be fused.

Open the upper jaws and insert pipe in each pair of jaws with applicable inserts installed.

Let the ends of the pipe protrude more than 25 mm (1") * past the face of the jaws.

* This distance changes with fusion machine type.

Tighten the clamp knobs on the outer jaws to prevent pipe slippage and lightly tighten inner clamp knobs for possible later alignment adjustments.

Hydraulic Butt Fusion Machine Procedure

Facing The Pipe

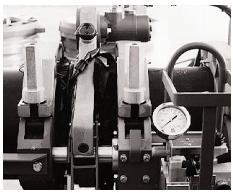
Pivot the facer into place and secure.

Move the carriage to the right.

Open the ball valve on the facer motor.

Assure the selector valve handle is up in the facing position.

Move the carriage to the left.



If the facer stalls, adjust the facing pressure so the facer continues to cut.

Important:
When facing heavy wall pipe, it may be necessary to increase the system pressure.

Important:
When drag pressure exceeds 20 Bar (300 psi) it is necessary to move the carriage to the left bringing the pipe ends into contact with the facer before opening the facer valve.

Let the carriage bottom out at the facer stops. Turn the facer off. Move the carriage to the right so the facer can be removed.

Hydraulic Butt Fusion Machine Procedure

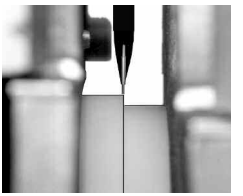
Remove Facer

Pivot the facer out to the storage position.

Remove chips from pipe ends, careful not to touch faced pipe ends.

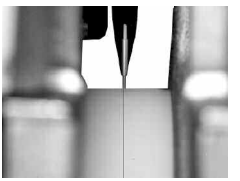
If faced pipe ends are touched, use clean non-synthetic cloth to clean affected area before proceeding.

Move the carriage to the left until ends of pipe butt together. Check pipe joint for proper alignment.



WARNING Do not use finger to check for hi/low (misalignment). The unit is under pressure, and slippage could result in crushed fingers. Always keep hands clear of the jaw area.

If pipe is not lined up, tighten the inner high side jaw to bring into alignment.



Important:
Always tighten the side that is higher, never loosen the low side.

When the pipe is properly aligned tighten outside clamps to insure against slippage.

If clamp knob adjustment has been made, reinstall facer and begin facing procedure again.

Let the carriage bottom out on facer stops. Turn facer off. Move the carriage to the right so the facer can be removed.

Remove chips from pipe ends careful not to touch faced pipe ends.

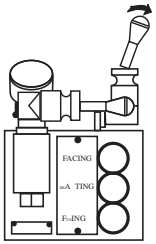
Bring the pipe ends together under fusion pressure to check for slippage. If slippage occurs, return to Loading Pipe Into Machine on page 36.

Notice:
Their should be no more than 10% of the wall thickness in misalignment to maintain full joint strength.

Hydraulic Butt Fusion Machine Procedure

Position Carriage For Heater Insertion

Move carriage to the right to open a gap large enough to insert the heater.



Check Heater Temperature

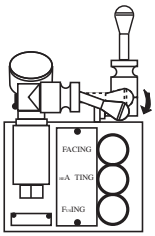
CAUTION Incorrect heating temperature can result in questionable fusion joints. Check heater plates periodically in multiple locations with a pyrometer and make necessary adjustments.

For butt fusion heater surface temperature should be Minimum 205°C (400° F), **Optimum 218°C (425° F)**, Maximum 230°C (450° F).

Important:
The dial thermometer on the heater indicates internal temperature. The dial thermometer can be used as reference once the surface temperature has been verified.

Select the Fusion Position

Move selector valve handle down to the fusing position. Use fusion pressure required from Fusion Pressure Calculator or the formula on page 35 . Also see Reference Section, page 80-85.

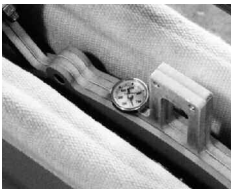


Hydraulic Butt Fusion Machine Procedure

Inserting Heater

⚠ DANGER Heater is Not Explosion Proof. Operation of heater in a hazardous environment without necessary safety precautions could result in explosion and death.

If operating in a hazardous environment, heater should be brought up to temperature in a safe environment,then unplugged before entering the hazardous atmosphere for fusion.



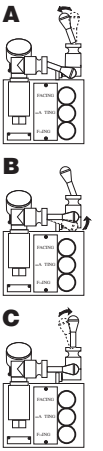
Use a clean non-synthetic cloth to clean the butt fusion heater adapter surfaces.

Check heater plates for coating damage, plastic buildup rings and surface imperfections. These conditions could cause a poor fusion. Replace them if conditions exist.

Verify heater temperature noting the reading on the dial thermometer.

Insert heater between the pipe ends.

Heating The Pipe



A) Move the carriage to the left under the fusion pressure, bringing the heater into contact with both pipe ends, seating pipe ends against heater. At first indication of melt around circumference of pipes, move to step B.

B) Move selector valve to center position, allowing pressure to drop and stabilize at lowest setting, in most cases “0”. When fusing more than one pipe length on the movable side of the fusion unit, drag must be compensated for.

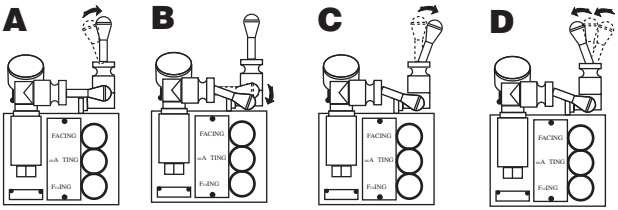
C) Return carriage control valve to neutral (middle) position. The pipe ends are now heating at “0” pressure or the pressure to compensate for drag, allowing the pipe ends to remain in contact with the heater.

Hydraulic Butt Fusion Machine Procedure

Fusing The Pipe

CAUTION Failure to follow the proper shift sequence, verify proper melt pattern and achieve proper cooling time may result in a bad joint.

After proper melt pattern has been established, use the **Approximate Melt Bead Size** chart on page 42 to determine the proper size, then:



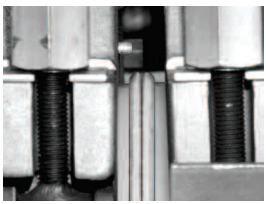
A) Shift carriage control valve to neutral position if not in this position already.

B) Shift the selector valve down to fusion position.

C) Move the carriage to the right just enough to remove the heater. The stripper bar on the heater should help "pop" heater loose. Quickly remove the heater without coming into contact with melted pipe ends.

D) Quickly inspect pipe ends, which should be flat, smooth, and completely melted. Concave pipe ends are unacceptable, see page 42. If acceptable, shift carriage control valve to the left immediately bringing ends together and apply fusion pressure, calculated from page 35 or obtained from fusion pressure charts in Reference Section, pages 80-85.

Notice:
Bring pipe ends together being careful not to exceed the **Approximate Dwell/Transfer Times** shown on page 42.



Hydraulic Butt Fusion Machine Procedure

Approximate Melt Bead Size (Pipe Ends)

Pipe Size	Approximate Melt Bead Size
40 mm (1-1/4") - 90 mm (3")	About 2 mm (1/16")
90 mm (3") - 200 mm (8")	3 mm (1/8") - 5 mm (3/16")
200 mm (8") - 315 mm (12")	5 mm (3/16") - 6 mm (1/4")
315 mm (12") - 630 mm (24")	6 mm (1/4") - 11 mm (7/16")
630 mm (24") - 900 mm (36")	About 11 mm (7/16")
900 mm (36") - 1600 mm (63")	About 14 mm (9/16")

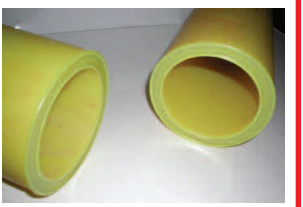
Approximate Dwell/Transfer Times

Pipe Size	Max. Transfer Time
90 mm (3") & smaller	4 sec.
110 mm (4") to 315 mm (12")	6 sec.
340 mm (13") to 630 mm (24")	9 sec.
710 mm (28") to 900 mm (36")	12 sec.
1000 mm (40") & Up	15 sec.

Unacceptable Concave Melt Appearance

What Causes This?

Answer - Heating under pressure.



Notice:
A concave melt surface is unacceptable; it indicates pressure during heating. Do not continue. Allow the melted ends to cool and start over.

Hydraulic Butt Fusion Machine Procedure

Cooling Of The Fusion Joint

The fusion joint must be kept under fusion pressure until joint is cool. This time will vary with pipe size, wall thickness, heater plate temperature setting and environmental conditions.

There are three acceptable methods that can be used individually or combined.

1) Cool to the touch.

⚠CAUTION If using this method, do not place hand or fingers in between jaws. The joint has pressure applied and the jaws could still slip at this point. Use a tool like a long handled screwdriver that can be used to probe weld bead. If tool makes an impression in weld bead, the weld bead is soft and has not cooled enough.

2) **Timing "Guidelines Only"**

Wall Thickness	**Cooling Time at 23° C (74° F)**
Up to 5 mm (0.2")	5 minutes
5 mm (0.2") to 10 mm (0.4")	5 to 10 minutes
10 mm (0.4") to 15 mm (0.6")	10 to 15 minutes
15 mm (0.6") to 20 mm (0.8")	15 to 20 minutes
20 mm (0.8") to 30 mm (1.2")	20 to 30 minutes
30 mm (1.2") to 40 mm (1.6")	30 to 40 minutes
40 mm (1.6") to 51 mm (2.0")	40 to 50 minutes
51 mm (2.0") to 61 mm (2.4")	50 to 60 minutes
61 mm (2.4") to 71 mm (2.8")	60 to 70 minutes
71 mm (2.8") to 81 mm (3.2")	70 to 80 minutes

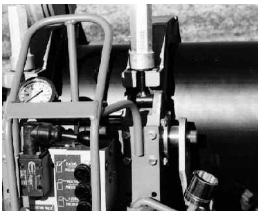
3) Use a pyrometer to measure temperature of the weld bead and compare it to the temperature of the pipes and or the fittings being fused. If the temperatures are the same, the cooling requirement has been met.

Notice:
Heavier wall thickness pipes require longer cooling times.

You must allow the joint to cool an additional thirty minutes minimum outside of the fusion machine before subjecting the fusion joint to any rough handling or severe bending.

Hydraulic Butt Fusion Machine Procedure

Opening Movable Jaws

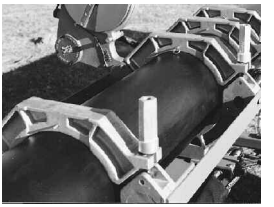


After the joint has cooled for the recommended time, shift the carriage control valve to the neutral position.

Loosen all clamp knobs, and move carriage to the right far enough to open the jaw nearest the facer.

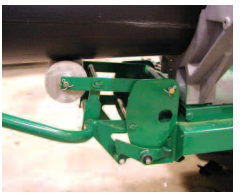
Open the movable jaws.

Opening Fixed Jaws



Open the fixed jaws

Raise Pipe



Raise the joined pipe using the pipe lift(s).

Pull Pipe through machine, and prepare for making next fusion. Inspect joint and if it has to be redone, use Trouble Shooting Guides on page 45 and 46 to determine problem and make adjustments before next fusion.

Hydraulic Butt Fusion Machine Procedure

Butt Fusion Joint Troubleshooting Guide

The Inspection Of The Fusion Joint

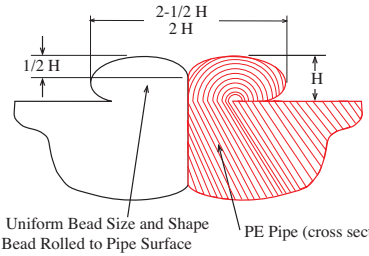
Golden Rule: If in doubt, cut it out and redo.

The double bead should be rolled over onto the adjacent surfaces, and be uniformly rounded and consistent in size all around the joint. As illustrated in the Figure below, the double bead width should be 2 to 2-1/2 times its height above the surface, and the v-groove depth between the beads should not be more than half the bead height.

When butt fusing to molded fittings, the fitting side bead may have an irregular appearance. This is acceptable provided the pipe side bead is correct.

It is not necessary for the internal bead to roll over to the inside surface of the pipe.

Butt Fusion Bead Proportions



Note: This is a "guideline" only and should not be taken solely as pass or fail. The bead may be in various configurations but they must satisfy the following requirements:

- There shall be no evidence of cracks or incomplete fusion.
- Joints shall not be visually mitered (angled, off-set). The ovality offset shall be less than 10% of the minimum wall thickness of the fused components.
- The cleavage between fusion beads shall not extend to or below the outside pipe diameter pipe surface.

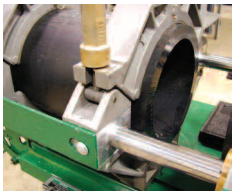
Hydraulic Butt Fusion Machine Procedure

Butt Fusion Joint Troubleshooting Guide

What Is Present	Attributing Factors
One bead larger than the other	Misalignment, component slipped in clamp, worn equipment, incomplete facing
Bead not rolled over to surface	Shallow v-groove - insufficient heating & insufficient joining force, deep v-groove - insufficient heating & excessive joining force
Squarish outer bead edge	Pressure during heating
Excessive double bead width	Overheating, excessive joining force
Flat top on bead	Excessive joining force, overheating
Beads too small	Insufficient heating or joining force
Beads too large	Excessive heating time
Rough, sand-paper like, bubbly, or pockmarked melt bead surface	Hydrocarbon contamination
Double v-groove too deep	Excessive joining force, insufficient heating, pressure during heating
Non-uniform bead size around pipe	Misalignment, defective heating tool, worn equipment, incomplete facing
A third bead	Excessive joining force

Hydraulic Butt Fusion Machine Procedure

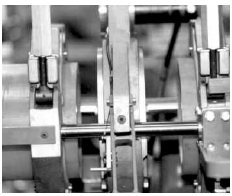
Position Pipe For Next Joint



Move the fusion machine to the end of pipe, or pull the pipe through the jaws until the end of the pipe is protruding more than 25 mm (1") * past the jaw face of the fixed jaw.

* This distance changes with fusion machine type.

Install Next Piece Of Pipe



Insert a new piece of pipe in the movable jaws and repeat all previous procedures.

Saddle Fusion Machine Procedure

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Saddle Fusion Machine Procedure

The theory of heat fusion is to heat two surfaces to a designated temperature, and then fuse them together by application of force. This pressure causes flow of the melted materials, which causes mixing and thus fusion. When the polyethylene material is heated, the molecular structure is transformed from a crystalline state into an amorphous condition. When fusion pressure is applied, the molecule from each polyethylene part mix. As the joint cools, the molecules return to their crystalline form, the original interfaces are gone, and the fitting and pipe have become one homogeneous unit.

The principle operations include:

Clamping	The pipe and fitting must be held firmly to allow all subsequent operations to take place.
Cleaning	The area of pipe that the fitting will come in contact with must be cleaned and roughed up, as well as the base of the fitting.
Alignment	The fitting must be properly seated on the pipe and then clamped in the machine for proper alignment.
Heating	A melt pattern must be formed that penetrates into the pipe and into the fitting.
Joining	The melt patterns must be joined with a specified force. The force must be constant around the interface area.
Holding	The molten joint must be held immobile with a specified force until adequately cooled.

Saddle Fusion Procedures

Definitions

Initial Heat (Bead-up): The heating step used to develop a melt bead on the main pipe.

Initial Heat Force (Bead-up force): The force applied to establish a melt pattern on the main pipe. The Initial Heat Force is determined by multiplying the fitting base area by the initial heat interfacial pressure (Bar per 25.4 mm^2). This force is twice the fusion force.

Heat Soak Force: The force applied after an initial melt pattern is established on the main pipe. The Heat Soak Force is the minimum force (essentially zero Bar) that ensures that the fitting, heater, and main stay in contact with each other.

Fusion Force: The force applied to establish the fusion bond between the fitting and the pipe. The Fusion Force is determined by multiplying the fitting base area by the fusion interfacial pressure (Bar per 25.4 mm^2).

Total Heat Time: A time that starts when the heater is placed on the main pipe and initial heat force is applied and ends when the heater is removed.

Cool Time: The time required to cool the joint to approximately 49°C (120°F). The fusion force must be maintained for five minutes on 40 mm (1-1/4" IPS) or ten minutes for all other main sizes, after which the saddle fusion equipment can be removed. The joint must be allowed to cool undisturbed for an additional thirty minutes before tapping the main or joining to the branch outlet.

Interfacial Area for Rectangular Base Fittings: The major width times the major length of the saddle base, without taking into account the curvature of the base or sides, minus the area of the hole in the center of the base.

Interfacial Area for Round Base Fittings: The radius of the saddle base squared times π (3.1416), without taking into account the curvature of the base or sides, minus the area of the hole in the center of the base.

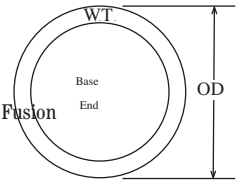
Fitting Label: The Initial Heat Force, Heat Soak Force, and the Fusion Force may be listed in the lower right corner of the fitting label for all saddle fusion fittings. This will eliminate the need to calculate the fusion forces in the field (example 80/0/40). Some manufacturers have this information on fitting labels but not all.

Saddle Fusion Procedures

How To Determine Fusion Pressures

Round Base

$$\frac{(\text{O.D. of Base} - \text{Wall Thickness}) \times \text{Wall Thickness} \times 3.14 \times \text{IFP*}}{\text{TEPA**}}$$



Notes:

*IFP = Interfacial Fusion Pressure is always 2 Bar (30 Psi) for Saddle Fusion

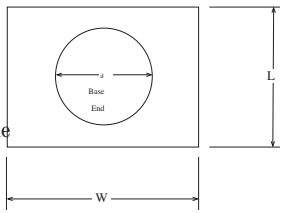
**TEPA = Total Effective Piston Area

*** Add 2 Bar (30 Psi) to your fusion pressure to compensate for drag when using hydraulic pump powered fusion equipment.

Examples: Sidewinders have 1 TEPA
No. 28 Combo has a 4.7 TEPA or 1.67 TEPA for a 250 unit

Rectangular Base

$$\frac{L \times W - (d \times d \times .7854) \times \text{IFP*}}{\text{TEPA**}}$$



Notes:

*IFP = Interfacial Fusion Pressure is always 2 Bar (30 Psi) for Saddle Fusion

**TEPA = Total Effective Piston Area

*** Add 2 Bar (30 Psi) to your fusion pressure to compensate for drag when using hydraulic pump powered fusion equipment.

Examples: Sidewinders have 1 (25.40) TEPA
No. 28 Combo (HF) has a 4.7 (3039) TEPA or 1.67 (1077) TEPA for a 250 (LF) unit

Saddle Fusion Procedures

Prepare Fusion Machine

This procedure requires the use of a Saddle Fusion Tool like the examples shown on the cover page of this procedure. This tool must be capable of holding and supporting the main, rounding the main for good alignment between the pipe and fitting, holding the fitting, applying and indicating the proper force during the fusion process.

Install the Saddle Fusion Tool on the main according to the manufacturer's instructions. The tool should be centered over a clean, dry location where the fitting will be fused. Secure the tool to the main. A main bolster or support is recommended under the pipe on 160 mm (6" IPS) and smaller main pipe sizes.

Abrade the fusion surface of the fitting with 50 to 60 grit utility cloth; to remove oxidation layer and contaminants. After abrading, brush residue away with a clean, dry cloth.

Saddle Fusion Procedures

Insert the fitting in the Saddle Fusion Tool loosely.

Abrade the fusion surface of the main with a 50-60 grit utility cloth to remove oxidation layer and contaminates. The abraded area must be larger than the area covered by the fitting base. After abrading, brush residue away with a clean, dry cloth.

Using the Saddle Fusion Tool, move the fitting base and apply about 7 Bar (100 pounds) force to seat the fitting. Secure the fitting in the Saddle Fusion Tool.

Heating

DANGER Heater is Not Explosion Proof. If working in a hazardous environment review pages 7, 13 and 14 in Safety Section.

CAUTION Incorrect heating temperature can result in questionable fusion joints. Check heater plates periodically in multiple locations with a pyrometer and make necessary adjustments.

The heater must be fitted with the correct heater adapters. Serrated heater adapters are recommended to allow for maximum heat penetration. The non-stick coating on the heater adapters should be in good condition. The temperature of the heater adapter fusion surfaces must be 255°C - 265°C (490-510° F), with **260°C (500°F)** being **Optimum.**

Important:
The dial thermometer on the heater indicates internal temperature. The dial thermometer can be used as reference once the surface temperature has been verified.

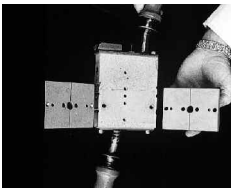
Saddle Fusion Procedures

Installing Fusion Heater Adapters

The heater body of this assembly is not coated. Coated heater adapters are available for all fusion applications.

Heater adapters are installed with Stainless Steel Cap Screws.

Care should be taken to assure that the heater adapters are seated on the heater body, and that there is no foreign matter trapped between these surfaces.



Important: Do not over-tighten the bolts.

The surface of the heater adapters are coated with an anti-stick coating.

Place the heating tool on the main centered beneath the fitting base. Immediately move the fitting against the heater faces, apply the Initial Heat Force, (see fitting label or use twice the calculated fusion pressure), and start the heat time.

Apply the Initial Heat Force until melt is first observed on the crown of the pipe main, (Initial Heat is the term used to describe the initial heating (bead-up) step to develop a melt bead on the main pipe and usually is 3-5 seconds) and then reduce the force to the Heat Soak Force (Bead-up Force) (see fitting label or use "0" psi.)

At the end of the Total Heat Time (See Below), remove the fitting from the heater and the heater from the main with a quick snapping action. Quickly check the melt pattern on the main pipe and fitting base for even melt patterns (no unheated areas).

Total Heat Time ends when:
See Page 55.

Saddle Fusion Procedures

Maximum Heating Time And Minimum Cooling Time

Main Size	**Maximum Heating Time**	**Minimum Cooling Time**
40 mm (1-1/4" IPS) all DR's Pressurized	Stop heating when about 2 mm (1/16") bead is visible all around fitting base. **Do not exceed 15 sec. when hot tapping** (blowout may occur if main line is pressurized.)	5 min. + 30 min.
63 mm (2" IPS) all DR's Pressurized	Stop heating when about 2 mm (1/16") bead is visible all around fitting base. **Do not exceed 35 sec. when hot tapping** (blowout may occur if main line is pressurized.)	10 min. + 30 min.
40 mm - 63 mm (1-1/4 - 2" IPS) all DR's Non-Pressurized	Stop heating when about 2 mm (1/16") bead is visible all around fitting base.	10 min. + 30 min.
90 mm (3" IPS) all DR's Non-Pressurized	Stop heating when about 2 mm (1/16")- 3 mm (1/8") bead is visible all around fitting base.	10 min. + 30 min.
110 mm (4" IPS) and Larger all DR's Non-Pressurized	Stop heating when about 3 mm (1/8") - 6 mm (1/4") bead is visible all around fitting base.	10 min. + 30 min.

Notice:
It is highly recommended that a trained ISCO Field Service Technician support you on projects involving pressurized mains greater than 63 mm (2" IPS) in size and branch saddles greater than 200 mm (8" IPS) in size.

Saddle Fusion Procedures

Fusion and Cooling

Whether or not the melt patterns are satisfactory, press the fitting onto the main pipe very quickly (within 3 seconds) after removing the heater and apply the Fusion Force (See the fitting label or use the formula on page 51 to calculate). Maintain the Fusion Force on the assembly for 5 minutes on 40 mm (1-1/4" IPS) mains and for 10 minutes on all larger sizes , after which the saddle fusion equipment may be removed. (Fusion Force adjustment may be required during Cooling Time, but never reduce the Fusion Force during the cooling).

Important:
Visually check the fusion bead around the entire fitting base at the main pipe. The fusion bead should be uniformly sized all around the fitting base, and should have a characteristic "three-bead" shape. The first bead is the fitting base melt bead. The second or outermost bead is produced by the edge of the heating tool face on the main. The third or center bead is the main pipe melt bead. The first and third beads should be about the same 3 mm (1/8") - 6 mm (1/4") size all around the fitting base. The second bead is usually smaller, but should also be uniformly sized around the fitting base.

The assembly should cool for an additional 30 minutes before rough handling or tapping the main. Inspect fusion using the troubleshooting guide on page 57 for proper melt patterns. If melt patterns are not satisfactory or if the fusion bead is unacceptable, cut off the saddle fitting above the base to prevent use and relocate to a new section of main. Then make a new saddle fusion using a new fitting.

Important:
These procedures are based on tests conducted under controlled ambient temperature conditions. Environmental conditions on a job site could affect heating and cooling times. Regardless of job site conditions or ambient temperature, the prescribed heating tool temperature is required. Do not increase or decrease the heating tool temperature.

Saddle Fusion Procedures

Troubleshooting Guide

Observed Condition	Possible Cause
Non-uniform bead size around fitting base	Misalignment; Defective heating tool; Loose or contaminated heating tool saddle faces; Worn equipment; Fitting not secured in application tool; Heating tool faces not within specified temperature
One bead larger than the other	Misalignment; Component slipped in clamp; Worn equipment; Defective heating tool; Loose or contaminated heating tool saddle faces; Heating tool faces not within specified temperature
Beads too small	Insufficient heating; Insufficient joining force
Beads too large	Excessive heating time; Excessive force
No third bead, or third bead widely separated from center bead	Incorrect pipe main heating tool face or insufficient joining force
Serrated bead appearance	Normal for serrated heating tool faces
Smooth bead appearance	Normal for smooth heating tool faces
Pressurized main pipe blowout (beside base or through fitting center)	Overheating; Incorrect heating tool faces; Heating tool faces not within specified temperature; Taking too much time to start heating or to remove the heating tool and join the fitting to the main pipe
Rough, sandpaper-like, bubbly, or pockmarked melt bead surface	Hydrocarbon contamination

Saddle Fusion Procedures