REV.	ECO	DESCRIPTION	DATE	BY
1	A13384	INITIAL RELEASE	2/3/99	TD
2	A13428	ENGINEERING RELEASE	2/18/99	KY
3	A13483	ENGINEERING RELEASE	3/22/99	RS

Filename: 93C07130.zip S.O. A20509

SVG Thermco

Functional Specification, W/D OXIDE w/HCl, NO, N_2O

UNITS OF MEASURE
STD. EA
NORM. PURCH.

RELEASED DATE

INITIAL _____

PRODUCTION _____

DRAWN BY: T. Dodwell

CHECKED BY:

APPROVED BY:

SIZE: A

DRAWING NO. 605191-013

REV. 2

SCALE:

SHEET 1 OF 13

Revision	Date	Description
1	2/3/99	Initial Release based on Gas Schematic 603567-19S, Rev. U2
2	2/18/99	Engineering Release
3	3/22/99	Engineering Changes: Section 2.3.1: Deleted "H2 Leak Detection (Alarm 9). Section 2.4: Deleted Section 2.4.1 "Additional relay backed up alarms on this tool". Section 2.6: Deleted H2 (Valve 2). Section 7.2: Changed 650°C to 900°C and added note. Section 7.8: Alarm 9 is no longer a GSD Alarm. Section 7: Deleted "HCl Manifold Pressure Low (Alarm 19). Renumbered section. Section 7.30: Added 6, 7, 8, 9. Section 9.0: Changed function of Alarm 2 and deleted Alarm 19. Section 11.0: Added interlock between Valve 14 and Valves 15/17. Added interlock between Valve 15 and Valve 14. Added interlock between Valve 17 and Valve 14. Section 1.1: Made changes to clarify the ON/OFF state of the Gas Valve/Automatic Valve. Section 9.0: Added remarks to Alarm 9 and Alarm 38. Section 11.0: Added Mutually Exclusive Interlock between: Valve 4 and Valve 5 Valve 4 and Valve 7 Valve 5 and Valve 8 Valve 15 and Valve 17 Created a class "K" alarm relationship between Alarm 38 and Valves 2, 12, 14, 17.

Table of Contents

1.0 Definitions

1.1 Gas Valves or Automatic Valves are defined as those valves located downstream from their associated MFCs. They are automatically given an ON command when a non-zero set point is sent to the associated MFC and they are automatically given an OFF command when a zero setpoint is sent to the associated MFC. They are identified by having the same ID number as the associated MFC (e.g., Valve1<->MFC1, Valve 2<-> MFC2, etc.). However, the ability of these valves to actually turn ON or OFF is individually controlled by interlock logic programmed within the Xilinx FPGA.

1.2 Process Valves or Non-Automatic Valves are defined as those valves that generally control the process. This group includes all other valves in the gas system. They must be given an ON command via recipe control. However, like the Automatic Valves the ability of these valves to actually turn ON or OFF is individually controlled by interlock logic programmed within the Xilinx FPGA.

1.3 Gas System Disabled (GSD) is defined as the state in which power to selected Gas Valve solenoids and Process Control valve solenoids is removed. This is designed to be a safe state. A User Interface is provided to indicate this state via sets of relay contacts. Certain alarms cause the system to enter this state. Once the tool enters this state it will remain in this state until the alarm causing the GSD has been cleared and the operator resets the system.

1.4 Redundant Relay Interlock is defined as the backup interlock system comprised of relay logic, employed in parallel with the Xilinx FPGA, and whose function is to interrupt power to selected solenoids in the event of a failure in the primary interlock system (Xilinx FPGA and related electronics).

1.5 Alternate Name Descriptions: Some entities have become known by more than one name:

1. Vacuum Gate valve (Valve 31) or Gate valve
2. Soft Start Vacuum valve (Valve 30) or Half-gate valve
3. Process Chamber or Process Tube or Tube
4. EPO (Emergency Power Off) or EMO (Emergency Off)

1.6 Mutually Exclusive Valves means that if one of two valves is ON, it disables the other from turning ON, and vice-versa. Also, if both are commanded ON at the same time, the first one detected by the system will take priority over the other.

1.7 Field Programmable Gate Array (FPGA) is a programmable integrated circuit device that can be used to program various outputs based on combinations of inputs. The inputs consist of valve commands from recipe control and alarm inputs from the system. The outputs consist of qualified valve outputs to operate valves and qualified alarm outputs that go to the operating system. Safety of the system depends on the safety logic programmed into the FPGA and the redundant relay interlocks.

2.0 Operation of Gas Valves

Each valve in the gas system is controlled by a signal from the Field Programmable Gate Array (FPGA). Signals generated by the recipe are sent to the FPGA. The FPGA processes the signal by internal programmed logic. If interlock conditions are met, the FPGA outputs a signal to a valve driver to control the valve. Redundant shutoff is provided to selected valves by relay logic.

There are four relay loops on the valve driver board that can be programmed to shut off selected valves. These loops are designated "A, B, C, and D". The "D" loop is a special loop reserved for System Disable Valves. These valves have their power interrupted by FPGA logic and by redundant relay logic if the tool enters the GSD state. Relay action also interrupts this loop if a LCA board circuit failure is detected. In addition to the four relay loops on the valve driver board an non-interruptible fifth loop (E) is provided for those valves that do not require relay interruption of power.

2.1 LCA Board Circuit Failure

Hardware circuitry and firmware on the LCA board monitor for the following faults:

1. Gas Interface Sub-System power supplies out of tolerance
2. Programmable Logic Array configuration load fault.
3. Detection of Programmable Logic Array Configuration corruption by the micro-controller auditor firmware.
4. Process Controller Watchdog.
5. Micro-controller Xilinx Watchdog (Subsystem failure).

These faults will shut off power to hazardous gas valves and turn on an audible alarm as long as the condition exists. When the fault is cleared the gas valves will turn back on. These fault conditions are not latched.

2.2 Gas System Disable (GSD) State

When certain interlocks programmed in the FPGA device are violated the FPGA will put the system in a latched GSD State. Upon entering this state, an audible alarm is sounded that may be silenced via a push-button switch located on the rear of the main unit, labeled "SILENCE ALARM", or at the front panel by clicking the mouse on a software-displayed button on the CRT. The indicator in the "SILENCE ALARM" switch is then turned ON to indicate that the alarm has been silenced. Once the alarm-causing condition has been cleared, the system must be manually reset via a lighted "RESET GAS SYSTEM DISABLE" push-button switch also located on the rear of the main.

2.3 Alarms Causing Gas System Disable State

Unless otherwise specified, the following alarms always cause the tool to enter the GSD State:

1. Gas Cabinet Exhaust Fault (Alarm 5)
2. Element Exhaust Fault (Alarm 8)
3. Cabinet Over Temperature (Alarm 10)
4. Scavenger Exhaust Fault (Alarm 11) ATM tools only
5. Gas Cabinet Door Open (Alarm 14)
6. Pump Fault (Alarm 15) CVD tools only
7. Element Removal (Alarm 33)
8. External System Disable Request (Alarm 37)

2.3.1 Additional alarms causing System Disable State on this tool.

In addition to the above listed alarms causing GSD State, the following alarms also cause the GSD state on this tool:

1. N_2 Pressure Low (Alarm 28).- If process gases are flowing

2.4 Relay Backup of Critical System Disable Alarms

Certain critical alarms are used to actuate relays as well as inputs to the FPGA. If one of these alarms become active, the associated relay de-energizes removing power from the selected valves thereby providing redundant shutoff. Most alarms that cause the FPGA to go into the GSD state are backed up by relays that control the System Disable power loop ('D' loop). Unless otherwise specified, the following GSD alarms are always backed up by a hardware relay:

1. Gas Cabinet Exhaust Fault (Alarm 5)
2. Element Exhaust Fault (Alarm 8)
3. Scavenger Exhaust Fault (Alarm 11) ATM tools only
4. Gas Cabinet Door Open (Alarm 14)
5. Pump Fault (Alarm 15) CVD tools only

2.5 Relay Backup of Alarms NOT Causing GSD State

Unless otherwise specified, the following alarms always shut off the power to System Disable Valves by relay action and by FPGA logic without causing GSD State:

1. AC Power Fault (Alarm 32)

2.6 Valve Shut-Off by Relay Action Only

The following alarms always interrupt power to System Disable Valves that are assigned to the relay 'D' Loop by relay action only:

1. Element Door Open (Alarm 59)
2. Gas System Watchdog (Alarm 38)

In this system the following valves are assigned to the relay 'D' Loop:

1. HCl High (Valve 4)
2. NO (Valve 5)
3. N_2O (Valve 7)
4. HCl Low (Valve 8)
5. H_2 Manifold Purge (Valve 9) – Normally Open Valve
6. HCl Manifold Purge (Valve 11) – Normally Open Valve
7. UHPN_2 Purge Enable (Valve 27) – Normally Open Valve

2.7 System Disable Valves Defined

All valves that enable a process gas considered hazardous to personnel or equipment are always considered System Disable Valves. In this tool the following valves are Gas System Disable Valves:

1. H_2 (Valve 2)
2. HCl High (Valve 4)
3. NO (Valve 5)
4. N_2O (Valve 7)
5. HCl Low (Valve 8)
6. H_2 Manifold Purge (Valve 9) – Normally Open Valve
7. HCl Manifold Purge (Valve 11) – Normally Open Valve
8. H_2 Enable (Valve 12)
9. HCl Enable (Valve 14)
10. NO Enable (Valve 15)
11. N_2O Enable (Valve 17)
12. $UHPN_2$ Purge Enable (Valve 27) – Normally Open Valve

2.8 Non-Interruptible Valves

In this system the following valves are not interlocked by other valves or alarms and are therefore controlled by operator recipe only:

1. Spare1 (Valve 33)
2. Spare2 (Valve 34)
3. Spare3 (Valve 35)

3.0 AC Power Fail and EPO Interface

When a Power Monitor relay de-energizes due to the system losing AC Power, a Power Fail signal (Alarm 47) is sent to the Process Controller. This same Power Fail signal also triggers a 30-second delay circuit that, after timing out, generates AC Power Fault (Alarm 32). Alarm 32 starts a 120-second timer. During this 120-second period the system operating on UPS power saves critical data and goes into a controlled shutdown. After the 120-second timer times out, an EPO signal is generated and all power to the system is removed.

However, should AC Power come "back up" before Alarm 32 becomes active, the system will not go into the EPO condition. In that case processing will continue as before power loss.

4.0 Gas Hour Meter (GHM)

Logic within the FPGA provides a run-time signal to drive a Gas Hour Meter for monitoring the primary process gas flow. In this system the process gas monitored is H_2. The following conditions send a signal to the GHM:

1. H_2 (Valve 2) and H_2 Enable (Valve 12) both must be ON.

5.0 Automatic N_2 Purge

There are two automatic N_2 purges in this tool. The **System Disable or Power Down** purge occurs if the system enters the System Disable State or if system power is lost. The **Timed Automatic Purge** occurs if process gases are flowing and N_2 Pressure Low (Alarm 28) becomes active. The H_2 manifold is purged via $UHPN_2$ Enable (Normally Open Valve 27), a 10 SLPM flow restrictor and N_2 Purge (Normally Open Valve 9). The HCl manifold is purged via $UHPN_2$ Enable (Normally Open Valve 27), a 10 SLPM flow restrictor and N_2 Purge (Normally Open Valve 11).

5.1 System Disable or Power Down Purge

This is a purge of both process loops by the same two N_2 purge valves described above, beginning immediately upon entering the Gas System Disabled state and continuing unabated until the system is manually reset. At that time, when the system is reset, both Valves 9 & 11 ($UHPN_2$ Purge-A/B) are energized into their normal non-flow states, ending the purge. This purge will occur in every case of Gas System Disabled state except that caused by N_2 Pressure Low alarm as described below. Of course if system power is lost the normally open purge valves will open and both manifolds will purge indefinitely.

5.2 Timed Automatic Purge

This purge will be initiated at the beginning of a Gas System Disabled state caused by N_2 Pressure Low (Alarm 28), while H_2, HCl, NO or N_2O gas is flowing. At this time, Alarm 36 (Elevator Disabled) will be activated to disable the elevator mechanism. Alarm 17 (N_2 Post Purge), a status indicator, will also be sent to the Process Controller. Purge valves 9 and 11 are de-energized to their flow states and a 10 minute countdown starts. If, after the purge begins, and before it completes, there are other occurrences of N_2 Pressure Low (Alarm 28), the purge countdown will suspend on each occurrence until N_2 pressure returns to non-alarm level again, and won't complete until a cumulative 10 minutes of N_2 purging has taken place. Alarm 17 (N_2 Post Purge) will indicate constantly from the time that N_2 Post Purge starts until the purge is completely

finished, and the elevator will be disabled by Alarm 36 (Elevator Disabled). During the period(s) when N_2 pressure is low out-of-range with Alarm 28 active, and the purge is suspended, both Valve 9 (UHPN_2 Purge-B) and Valve 11 are temporarily energized to their non-flow states. At the completion of N_2 Post Purge and after the System Disable alarm is reset, both Valves 9 & 11 (UHPN_2 Purge-A/B) are energized into their normal non-flow states.

6.0 Gas System Valve Interlocks

Valve to Valve interlocks are implemented by logic within the FPGA. Refer to the Valve and Alarm Interlock Matrix at the end of this document for Valve to Valve interlocks.

7.0 Gas System Alarms Defined

Certain alarms in this section interlock gas valves to inhibit gas flows based on the safety interlocks programmed in the FPGA and redundant relay interlocks. Refer to the Valve and Alarm Interlock Matrix at the end of this document for interlocks.

7.1 Torch Temperature less then 650 °C (Alarm 1)

The torch temperature must be greater than **650°C** before H_2 gas can flow (Valve 2 turned ON). Alarm 1 is used as an **H_2** process scenario start-up alarm only, and as such, has no effect once H_2 gas is flowing; the alarm then being "masked" (transparent to system operation) by Xilinx FPGA logic.

7.2 Torch Temperature between 350°C and 900°C (Alarm 2)

Torch temperature must remain in the range of **350°C to 900°C** while H_2 gas is flowing, otherwise Valves 2 and 12 will be forced off. Alarm 2 is a "masked" alarm; meaning it will **not** be passed to the Process Controller for status, **nor** will it be used for interlocks by the Xilinx FPGA, unless H_2 gas is flowing. Once the alarm occurs, it will be latched within the FPGA until zero setpoint is sent to **H_2** MFC2.

Note: Torch Overtemp Alarm was increased to 1025°C to allow operation up to 1000°C.

7.3 Flame Detect (Alarm 3)

A flame detector at the torch must detect a flame within ***15 seconds*** after **H_2 gas** begins flowing, or else Valves 2 and 12 will be forced off. Any loss of flame after initial ignition will cause an immediate activation of ***Alarm 3***, shutting off **H_2** Valves 2 and 12. Alarm 3 is a "masked" alarm; meaning that will **not** be passed to the Process Controller for status, **nor** will it be used for interlocks by the Xilinx FPGA, unless H_2 gas is flowing. Once the alarm occurs, it will be latched within the FPGA until zero setpoint is sent to **H_2** MFC2.

7.4 H_2/O_2 Ratio (Alarm 4)

If the maximum ratio of Hydrogen gas to Oxygen gas of **1.9:1** is exceeded during **H_2 processing** (wet oxidation), Valves 2 and 12 will be forced off. Alarm 4 is a "masked" alarm; meaning that it will **not** be passed to the Process Controller for status, **nor** will it be used for interlocks by the Xilinx FPGA, unless H_2 gas is flowing. Once the alarm occurs, it will be latched within the FPGA until zero setpoint is sent to **H_2** MFC2.

7.5 Gas Cabinet Exhaust Fault (Alarm 5) - GSD Alarm

Loss of gas cabinet exhaust for 10 seconds as monitored by a photohelic sensor will cause alarm 5 to be generated. This alarm shuts off process gas flows and causes the system to enter the latched Gas System Disable State.

7.6 Process Door Open (Alarm 6)

When the process door is open alarm 6 becomes active.

7.7 Element Exhaust Fault (Alarm 8) - GSD Alarm

Loss of element exhaust for 10 seconds as monitored by a photohelic sensor will cause alarm 8 to be generated. This alarm shuts off process gas flow and causes the system to enter the latched Gas System Disable State.

7.8 H_2 Leak Detect (Alarm 9)

Detection of hydrogen gas by a sensor will cause Alarm 9 to become active..

7.9 Cabinet Over Temperature (Alarm 10) - GSD Alarm

When a temperature sensor in the top of the main detects a temperature greater than 62 ºC, alarm 10 is active. This alarm shuts off process gas flow, shuts off element power and causes the system to enter the latched Gas System Disable State.

7.10 Scavenger Exhaust Fault (Alarm 11) - GSD Alarm

Loss of scavenger exhaust for 10 seconds as monitored by a photohelic sensor will cause alarm 11 to be generated. This alarm shuts off process gas flow and causes the system to enter the Gas System Disable State.

7.11 Gas Cabinet Door Open (Alarm 14) - GSD Alarm

When the gas cabinet door is open this alarm becomes active. This alarm shuts off process gas flows and causes the system to enter the latched Gas System Disable State.

7.12 Element Temperature less than 650°C (Alarm 15)

The main element temperature must be maintained above **650°C**, or H2 Enable (Valve 12) will be disabled.

7.13 Low Water Flow (Alarm 16)

This alarm occurs if the water flow falls below the preset minimum flow rate. This alarm is advisory only and is not used to interlock valves.

7.14 N_2 Post Purge (Alarm 17)

This alarm occurs if the system goes into a Timed Automatic Purge. This alarm remains on as long as the timed purge is active.

7.15 Ar Pressure Low (Alarm 18)

This alarm becomes active if the Ar pressure falls below 10 psig ±5 psig as measured by pressure transducer PT10. This alarm is advisory only and is not used to interlock valves.

7.16 NO Pressure Low (Alarm 21)

This alarm becomes active if the NO pressure falls below 10 psig as measured by pressure transducer PT5. This alarm is advisory only and is not used to interlock valves.

7.17 N_2O Pressure Low (Alarm 23)

This alarm becomes active if the N_2O pressure falls below 10 psig ±5 psig as measured by pressure transducer PT7. This alarm is advisory only and is not used to interlock valves.

7.18 N_2 Purge Pressure Low (Alarm 24)

This alarm becomes active if the N_2 pressure falls below 10 psig ±5 psig as measured by pressure transducer PT8. This alarm is advisory only and is not used to interlock valves.

7.19 HCl Leak Detection (Alarm 25)

This alarm becomes active if a sensor detects HCl.

7.20 High H_2 Flow (Alarm 26)

H_2 gas flow via MFC2 must be below **90%** of full scale flow, or Valves 2 and 12 will be forced off. Alarm 26 is a "masked" alarm; meaning it will **not** be passed to the Process Controller for status, **nor** will it be used for interlocks by the Xilinx FPGA, unless H_2 gas is flowing. Once the alarm occurs, it will be latched within the FPGA until zero setpoint is sent to **H_2** MFC2.

7.21 Pneumatic Pressure Low (Alarm 27)

This alarm becomes active if the pneumatic pressure is less than 60 psig ±5 psig as measured by a pressure switch in the pneumatic line.

7.22 N_2 Pressure Low (Alarm 28)

This alarm becomes active when the N_2 Line Purge pressure is below 10 psig ±5 psig as measured by pressure transducer PT1.

7.23 H_2 Pressure High (Alarm 29)

This alarm becomes active when the H2 pressure is above 33 psig ±5 psig as measured by pressure transducer PT2. This alarm is advisory only and is not used to interlock valves.

7.24 O_2 Pressure Low (Alarm 30)

This alarm becomes active when the O_2 pressure is below 10 psig ±5 psig as measured by pressure transducer PT3. This alarm is advisory only and is not used to interlock valves.

7.25 HCl Pressure Low (Alarm 31)

This alarm becomes active when the HCl pressure is below 10 psig ±5 psig as measured by pressure transducer PT4.

7.26 AC Power Fault (Alarm 32)

This alarm becomes active when AC input power is lost for more than 30 seconds ±5 seconds. This alarm shuts off process gas flows and seals off tube.

7.27 Element Removal (Alarm 33) - GSD Alarm

This alarm becomes active when the chamber is moved from its normal processing position. This alarm shuts off process gas flows and causes the system to enter the Gas System Disable State.

7.28 H_2 Flowing (Alarm 34)

This alarm becomes active when H_2 is flowing. This alarm is advisory only and is not used to interlock valves.

7.29 Torch Shield Open (Alarm 35)

This alarm becomes active if the torch shield is open.

7.30 Elevator Disable (Alarm 36)

This alarm is a reporting alarm only with no gas valve interlocks and is generated by the logic within the Xilinx FPGA under the following conditions:

1. H_2 Gas is flowing.
2. HCl Gas is flowing.
3. NO Gas is flowing.
4. N_2O Gas is flowing
5. During N_2 Post Purge.

Certain Gas System Disable alarms also cause Alarm 36 to become active, disabling the elevator.

6. Gas Cabinet Exhaust Fault (Alarm 5).
7. Scavenger Exhaust Fault (Alarm 11).

8. Element Removal (Alarm 33).
9. Ext System Disable Request (Alarm 37).

7.31 External Gas System Disable Request (Alarm 37) - GSD Alarm

This alarm is generated by customer and routed to the tool via customer I/O panel. This alarm shuts off process gas flows and causes the system to enter the latched Gas System Disable State as defined above.

7.32 Gas System Watchdog (Alarm 38)

A gas system watchdog circuit located on the LCA board monitors the integrity of the process controller. This circuit monitors a periodic signal sent by the process controller. If the circuit fails to receive this signal within 10 seconds, a watchdog alarm is generated. This alarm disables a relay in the GSD "D" loop that shuts off process gas flow. This alarm is not latched.

7.33 Element Door Open (Alarm 59)

This alarm becomes active when the heater door is opened. This alarm disables a relay in the GSD "D" loop that shuts off process gas flows. This alarm is not latched.

7.0 List of Gas System Valves and MFC's

Valve #	Valve Function	MFC#	Gas	Max Flow	Remarks	Valve Type	Relay Loop	*SD Valve
1	N2	1	N2	20 SLPM		Closed	E	
2	H2	2	H2	10 SLPM		Closed	D	X
3	O2 High	3	O2	20 SLPM		Closed	E	
4	HCl High	4	HCl	750 sccm		Closed	D	X
5	NO	5	NO	2 SLPM		Closed	D	X
6	O2 Low	6	O2	1 SLPM		Closed	E	
7	N2O	7	N2O	20 SLPM		Closed	D	X
8	HCl Low	8	HCl	50 sccm		Closed	D	X
9	H2 Manifold Purge	-	N2	10 SLPM	Flow Restrictor - No MFC	Open	D	X
10	Argon	10	Ar	20 SLPM		Closed	E	
**11	HCl Manifold Purge	-	N2	1 SLPM	Flow Restrictor - No MFC	Open	D	X
12	H2 Enable				Analog Boat Temperature Feedback	Closed	C	X
13	O2 High Enable		N2	20 SLPM	(MFM) MFC2, 5, 6, 7 & 10 Purge	Closed	E	
14	HCl Enable					Closed	C	X
15	NO Enable					Closed	C	X
16	O2 Low Enable					Closed	E	
17	N2O Enable					Closed	C	X
18	-							
19	MFC 2 Purge (H2)					Closed	E	
20	Ar Enable					Closed	E	
21	MFC 4/8 Purge (HCl)					Closed	E	
22	MFC 7 Purge (N2O)					Closed	E	
23	MFC 5 Purge (NO)					Closed	E	
24	MFC 10 Purge (Ar)					Closed	E	
25	MFC 6 Purge (LoO2)					Closed	E	
26	MFC 3 Purge (HiO2)					Closed	E	
27	UHPN2 Enable					Open	D	
28	MFC 1 Purge (N2)					Closed	E	
29								
30								
31								
32	-							
33	Spare Valve 1						E	
34	Spare Valve 2						E	
35	Spare Valve 3						E	
36	-							
37	-							
38	-							
39	-							

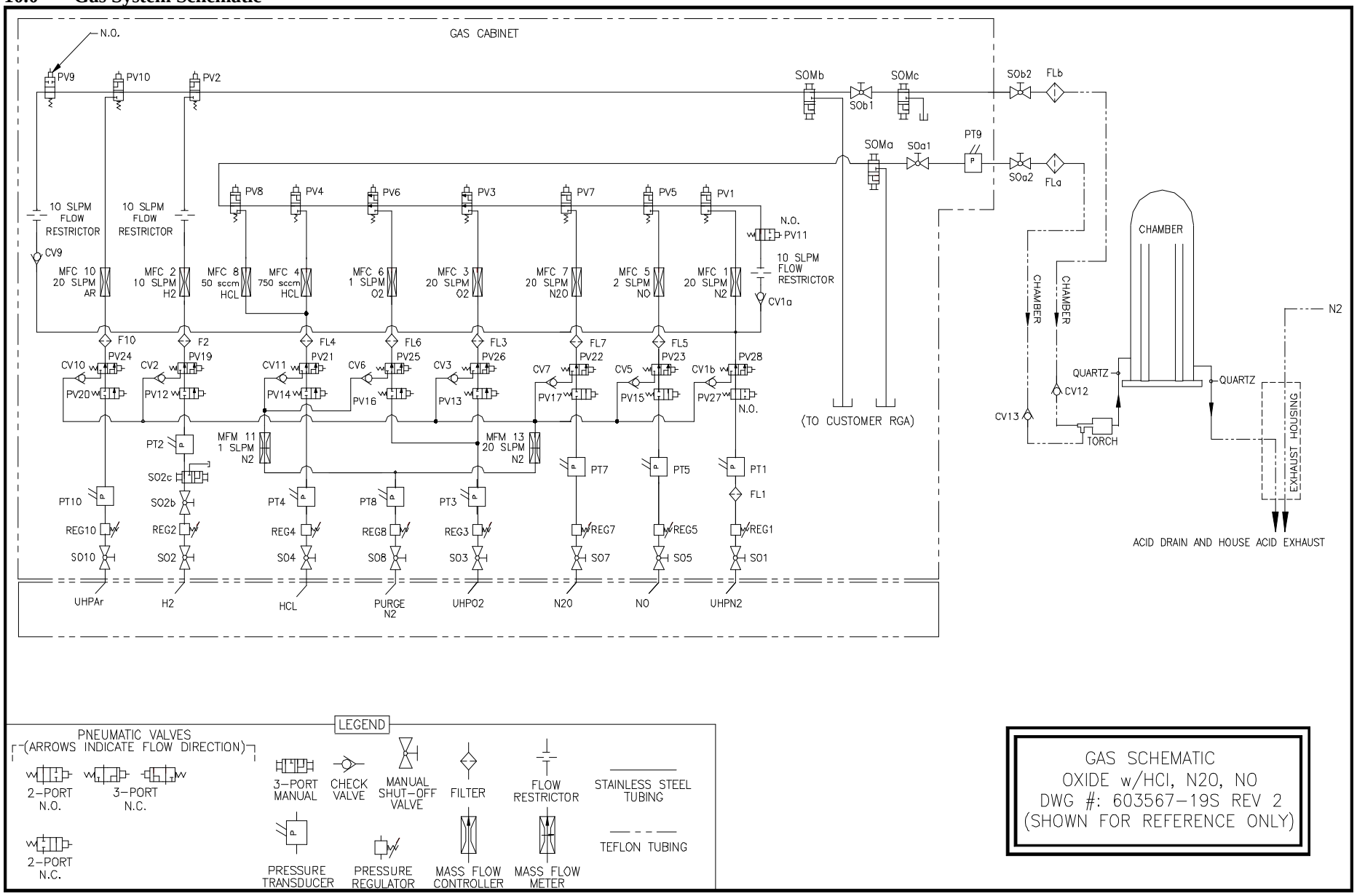
* SD = 'System Disable' valves are disabled if a System Disable Alarm becomes active.
**Note - MFM11 measures MFC4 and MFC6 Purge flow, Valve 11 is a Purge valve for the HCl Manifold.

8.0 List of Gas System Alarms

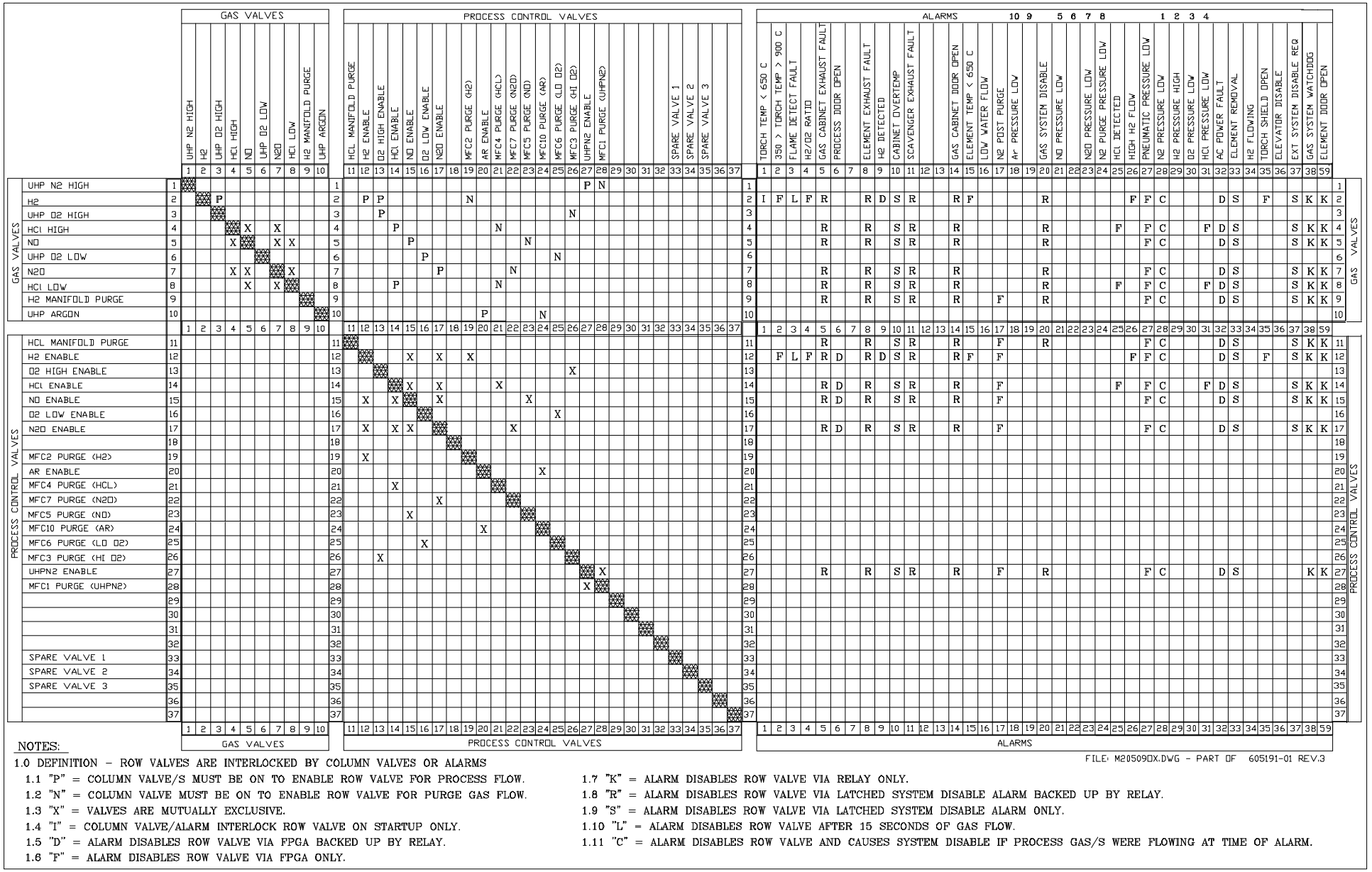
Alm #	Function	S	R	F	Remarks	Relay Loop
1	Torch Temperature < 650 C			X	H2 Start Up condition only -masked	
2	350 C> Torch Temperature > 900 C			X	Less than 350 C or greater than 900 C	
3	Flame Detect Fault			X	masked for the first 15 seconds of H2	
4	H2 / O2 Ratio > 1.9:1			X		
5	Gas Cabinet Exhaust Fault	X	X	X	Loss of exhaust for 10 seconds	C/D
6	Process Door Open		X	X		C
7						
8	Element Exhaust Fault	X	X	X	Loss of exhaust for 10 seconds	C/D
9	H2 Detected		X	X	Causes an audible alrm and available	C/D
10	Cabinet Over Temperature	X		X	Cabinet temperature greater than 62	
11	Scavenger Exhaust Fault	X	X	X	Loss of exhaust for 10 seconds	C/D
12						
13						
14	Gas Cabinet Door Open	X	X	X		C/D
15	Element Temperature < 650 C			X		
16	Low Water Flow					
17	N2 Post Purge					
18	Ar Pressure Low				(GP10) Pressure transducer less than	
19						
20	System Disable	X	X	X		
21	NO Pressure Low				(GP5) Pressure Transducer less than	
22						
23	N2O Pressure Low				(GP7) Pressure transducer less than	
24	N2 Purge Pressure Low				(GP8) Pressure transducer less than	
25	HCl Detected			X		
26	High H2 Flow			X		
27	Pneumatic Pressure Low			X	Pressure transducer less than 60 psig	
28	N2 Pressure Low			X	(GP1) Pressure transducer less than	
29	H2 Pressure High				(GP2) Pressure transducer greater	
30	O2 Pressure Low				(GP3) Pressure transducer less than	
31	HCl Pressure Low				(GP4) Pressure transducer less than	
32	AC Power Fault		X	X	Alarm 47 delayed 30 seconds	A/C/
33	Element Removal	X		X		
34	H2 Flowing					
35	Torch Shield Open			X		
36	Elevator Disabled					
37	External System Disable Request	X		X		
38	Gas System Watchdog		X		Alarm 38 is an unlatched system	D
47	AC Power Fail				Generates Alarm 32 after	
59	Element Door Open		X		Shuts off Element power	C/D

Notes:
S= System Disable Alarm.
R= Relay back up of alarm.
F= FPGA alarm interlock

10.0 Gas System Schematic



11.0 Valve and Alarm Interlock Matrix



NOTES:

1.0 DEFINITION - ROW VALVES ARE INTERLOCKED BY COLUMN VALVES OR ALARMS

1.1 "P" = COLUMN VALVE/S MUST BE ON TO ENABLE ROW VALVE FOR PROCESS FLOW.

1.2 "N" = COLUMN VALVE MUST BE ON TO ENABLE ROW VALVE FOR PURGE GAS FLOW.

1.3 "X" = VALVES ARE MUTUALLY EXCLUSIVE.

1.4 "I" = COLUMN VALVE/ALARM INTERLOCK ROW VALVE ON STARTUP ONLY.

1.5 "D" = ALARM DISABLES ROW VALVE VIA FPGA BACKED UP BY RELAY.

1.6 "F" = ALARM DISABLES ROW VALVE VIA FPGA ONLY.

1.7 "K" = ALARM DISABLES ROW VALVE VIA RELAY ONLY.

1.8 "R" = ALARM DISABLES ROW VALVE VIA LATCHED SYSTEM DISABLE ALARM BACKED UP BY RELAY.

1.9 "S" = ALARM DISABLES ROW VALVE VIA LATCHED SYSTEM DISABLE ALARM ONLY.

1.10 "L" = ALARM DISABLES ROW VALVE AFTER 15 SECONDS OF GAS FLOW.

1.11 "C" = ALARM DISABLES ROW VALVE AND CAUSES SYSTEM DISABLE IF PROCESS GAS/S WERE FLOWING AT TIME OF ALARM.

FILE: M20509DX.DWG - PART OF 605191-01 REV.3