

OWNER

Pre-commissioning, Commissioning and Startup



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ISSUE SUMMARY AND APPROVAL

This page records each issue of SPC-SPC-018. The preparer, reviewer and approver sign for each revision.

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Contributors

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A	Specifications			

SECTION PC-SPC-018

PRE-COMMISSIONING, COMMISSIONING AND STARTUP

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes the work that takes the from mechanical completion to handover for commercial operation:
1. System and subsystem definition, with boundaries marked on the P&IDs, and completion by system.
 2. Mechanical completion inspections, checklists and punch listing.
 3. Pre-commissioning: cleaning, flushing and blowing, reinstatement, instrument calibration verification, loop checks, motor rotation, valve and actuator stroke testing, and electrical energization checks.
 4. Support of factory acceptance tests (FAT) and performance of site acceptance tests (SAT) for the safety programmable logic controller (PLC), remote terminal unit (RTU), flow computer FQI-110, analyzers, ultrasonic meters, burner management system BMS-150 and uninterruptible power supplies (UPS).
 5. Functional testing of the cause-and-effect matrix and the alarm and trip settings.
 6. Validation of the safety instrumented system (SIS), including the overpressure shutdown system (OPSS).
 7. Support of the pre-startup safety review (PSSR).
 8. Introduction of gas (gas-in), coordinated with SPC-SPC-012.
 9. Startup of line heater H-101 and BMS-150.
 10. Measurement commissioning, witnessed by (the receiving pipeline operator).
 11. Initial startup, the 72 hour performance test and the handover certificates.
 12. Operator and maintenance training and vendor representative coordination.
- B. Related sections:
1. SPC-SPC-001, General Requirements and Definitions (management of change).
 2. SPC-SPC-011, Hydrostatic Testing, Dewatering and Drying (a prerequisite to this section).
 3. SPC-SPC-012, Tie-in, Hot Tap Coordination and Purging.
 4. SPC-SPC-013, Electrical Installation in Hazardous Locations; SPC-SPC-014, Instrumentation Installation, Tubing and Calibration; SPC-SPC-015, Cathodic Protection Installation and Testing; SPC-SPC-017, Mechanical Equipment Setting.
 5. SPC-SPC-019, Inspection and Test Plan; SPC-SPC-020, Construction Records and Turnover.



C. Work by others:

1. The hot tap on the trunkline, the tap valve, the receiving pipeline operator's RTU and its remote shutoff: (HOLD H-01, H-04).
2. Operation of the Owner's upstream lateral and treating facility, and supply of gas for commissioning: the Owner.
3. Acceptance of flow, nominations and the data link by the receiving pipeline operator's gas control: .
4. Energization of transformer XF-101 and the utility service: the electric cooperative (HOLD H-10).
5. Vendor commissioning services for Owner-furnished packages: the vendors under Owner purchase orders, coordinated and supported by the Contractor.

D. Responsibilities:

1. The Contractor shall perform pre-commissioning; supply commissioning labor, craft, tools, temporary equipment, nitrogen and consumables; perform loop checks and functional tests; support vendor representatives; and maintain the commissioning database.
2. The Owner will lead commissioning after Ready for Commissioning, operate the station after gas-in, chair the PSSR and issue operating permits.
3. The EOR will review procedures, witness SIS validation and the OPSS test, and co-sign the stage 3 functional safety assessment with the Owner's independent assessor.
4. The receiving pipeline operator will witness OPSS testing, measurement commissioning and first delivery under the Interconnect and Operating Agreement (HOLD H-01).

1.02 REFERENCES

A. Codes and standards, latest edition in force on the date of the contract unless an edition is stated:

1. 49 CFR 192.195, 192.199 and 192.201 (overpressure protection); 192.605 (procedural manual, in place before gas-in); 192.739 and 192.743 (pressure limiting station inspection and testing); 192.619 (maximum allowable operating pressure); 192 Subpart N (operator qualification).
2. 165:20, Gas and Hazardous Liquid Pipeline Safety.
3. IEC 61511-1:2016 with Amendment 1:2017, Functional Safety: Safety Instrumented Systems for the Process Industry Sector: 5.2.6.1 (functional safety assessment), Clause 13 (factory acceptance testing), Clause 14 (installation and commissioning), Clause 15 (SIS safety validation) and Clause 16 (operation and maintenance, including bypasses and proof testing).
4. ANSI/ISA-61511-1-2018, the United States adoption of IEC 61511-1:2016.
5. API RP 556, Instrumentation, Control, and Protective Systems for Gas Fired Heaters; API Specification 12K, Indirect-type Oil-field Heaters.

6. NFPA 70-2023, National Electrical Code; NFPA 70E-2024; NFPA 54-2024, National Fuel Gas Code.
7. AGA Report No. 9 (2022), Measurement of Gas by Multipath Ultrasonic Meters; AGA Report No. 8, Parts 1 and 2; AGA Report No. 10, Speed of Sound.
8. API MPMS Chapters 13, 14.1 and 21.1; GPA 2261 and GPA 2198.
9. API Standard 1164, Pipeline Control Systems Cybersecurity.
10. 29 CFR 1910.147 and 1926.417, lockout and tagout.

B. 29 CFR 1910.119, Process Safety Management, does not apply: the station is a natural gas pipeline facility, and its gas inventory is below the 10,000 lb threshold. The Owner will nevertheless conduct a PSSR as good practice.

C. Project documents:

1. GEN-DB-001, Basis of Design; PRO-DWG-001, Process Flow Diagram; PRO-DWG-101 to PRO-DWG-111, P&IDs.
2. INS-RPT-001, Control Philosophy and Functional Narrative; INS-LST-001, Instrument Index; INS-LST-002, I/O List; INS-LST-003, Alarm and Trip Setpoint Schedule; INS-LST-004, Cause and Effect Matrix; INS-DWG-001, Control System and Network Architecture.
3. SAF-SRS-001, Safety Requirements Specification; SAF-RPT-002, Layer of Protection Analysis; SAF-CAL-001, SIL Verification; SAF-RPT-001, Preliminary HAZOP; SAF-RPT-003 and SAF-DWG-001, Fire and Gas Detection.
4. PRO-CAL-009, Overpressure Protection System Hydraulic Analysis.
5. MEA-CAL-001, Ultrasonic Meter Sizing and Meter Run Design; MEA-DS-008, Flow Computer FQI-110; MEA-PRC-001, Meter Verification and Series Comparison Procedure.
6. ELE-DWG-001, One-Line Diagram; ELE-RPT-001 and ELE-DWG-002, Hazardous Area Classification; CP-CAL-001, Cathodic Protection Design.
7. MEC-DS-003, H-101 Line Heater; MEC-CAL-004, Piping Flexibility and Stress Screening.
8. CON-RPT-001, Construction Execution Plan; CON-RPT-003, Construction HSE Plan; CON-RPT-004, Operations and Maintenance Manual Outline.

1.03 DEFINITIONS

- A. System: a functional part of the station listed in 3.01, used as the unit of completion and handover. Subsystem: a part of a system that can be pre-commissioned on its own, for example SYS-03.1, meter run 1.
- B. Mechanical completion (MC): installed, tested (hydrotest, NDE, insulation tests) and documented per design, with no Category A punch items.

- C. Ready for commissioning (RFC): pre-commissioning complete, loop checks passed, and the system turned over to the Owner's commissioning lead.
- D. Ready for startup (RFSU): commissioning complete, SIS validated and PSSR items required before startup closed, so that gas may be introduced.
- E. Provisional acceptance (PA): performance test passed, Category B items listed with dates, and records turned over under SPC-SPC-020.
- F. Punch categories:
1. Category A: a defect that prevents safe commissioning or startup, or affects pressure integrity, a safety function or custody measurement. It shall be closed before RFC, or before RFSU if found during commissioning.
 2. Category B: a defect that does not prevent safe startup, to be closed before PA or by an agreed date.
 3. Category C: a cosmetic or documentation item, to be closed before final acceptance.
- G. Safety instrumented function (SIF); partial-stroke test (PST); lockout and tagout (LOTO).

1.04 SUBMITTALS

- A. The Contractor shall submit the items in Table 1-1.

Table 1-1: Submittal Schedule

No.	Submittal	Timing	Action
18-01	Commissioning execution plan: organization, system list, sequence, schedule, resources and interfaces with the receiving pipeline operator and vendors	60 days before the first MC	Owner approval
18-02	System boundary P&IDs, color-coded by system, and system registers (equipment, lines, instruments and cables in each system), including the P&ID sheet assignment for each system	60 days before the first MC	Owner approval
18-03	Commissioning database and checklist templates by discipline and equipment type	45 days before the first MC	Owner approval
18-04	Flushing and blowing procedure with cleanliness targets	30 days before use	Owner approval
18-05	Loop check procedure and loop folder format	30 days before loop checks	Owner approval
18-06	Vendor FAT procedures: safety PLC, RTU, flow computer, analyzer shelter B-101, BMS-150, UPS	30 days before each FAT	Owner review
18-07	SAT procedures for the same packages and the ultrasonic meter site checks	30 days before SAT	Owner approval

No.	Submittal	Timing	Action
18-08	Cause-and-effect functional test procedure, with a step for every row and column of INS-LST-004	30 days before the test	Owner approval
18-09	SIS validation plan and procedure, including the OPSS voting test, bypass tests, partial-stroke test and draft proof test procedure	45 days before validation	EOR approval
18-10	H-101 and BMS-150 startup procedure (vendor)	30 days before startup	Owner review
18-11	Gas-in and pressurization procedure, with SPC-SPC-012	30 days before gas-in	Owner approval; EOR and receiving pipeline operator review
18-12	Measurement commissioning procedure: flow computer configuration check, zero-flow verification, series verification, analyzer calibration	30 days before measurement commissioning	Owner approval; receiving pipeline operator review
18-13	Performance test procedure	30 days before the test	Owner approval
18-14	Training plan and materials	30 days before training	Owner review
18-15	Weekly commissioning status: checklist progress by system, punch list by category, open holds	Weekly	Information
18-16	Signed MC, RFC, RFSU and PA certificates with their checklists	At each milestone	Owner and EOR approval
18-17	SIS validation report and stage 3 functional safety assessment record	Before RFSU	EOR approval
18-18	Performance test report	7 days after the test	Owner approval
18-19	Commissioning dossier: all executed checklists, test records, calibration and loop sheets	Before PA	Owner approval

1.05 QUALITY ASSURANCE

- A. Hold and witness points shall be as listed in 3.15 and in SPC-SPC-019.
- B. Test equipment shall carry calibrations traceable to the National Institute of Standards and Technology (NIST), not older than 12 months.
- C. Every checklist, test record and punch item shall be entered in the commissioning database within 24 hours of execution, with a unique ID, system and tag references and a scan of the signed form.
- D. Every failed test shall be recorded as a nonconformance with its root cause, correction and retest. After any change to SIS logic, the affected validation steps shall be repeated and the change reviewed under the functional safety management plan.

- E. The software version, application checksum and configuration file of every programmable device shall be recorded at FAT and verified unchanged at SAT, except for changes documented under management of change.

1.06 MEASUREMENT AND PAYMENT

- A. Pay item 18.01, Pre-commissioning and mechanical completion: lump sum. The price shall include the system registers, MC walk-downs and checklists, punch listing, flushing and blowing, reinstatement, loop checks, motor and actuator tests, energization tests including a 30 minute UPS discharge test, SAT support and cause-and-effect test labor, temporary strainers and blinds, nitrogen for blowing, test equipment and the commissioning database. It is paid 40 % at MC of all systems and 60 % at RFC of all systems.
- B. Pay item 18.02, Commissioning, startup and performance test support: lump sum. The price shall include SIS validation support with the integrator, gas-in craft support, heater startup support including a deferred cold-weather return, measurement commissioning support, craft and technician standby during the 72 hour performance test and any retest under 3.12 A, temporary strainer removal, and training coordination and facilities. It is paid 30 % at RFSU, 40 % on a successful performance test and 30 % at PA.
- C. Vendor representative fees, calibration gases, Owner operators, costs of the receiving pipeline operator and the independent functional safety assessor are excluded.
- D. Repeat tests caused by Contractor defects shall not be paid. Contractor crews held at site at the Owner's request because of delay by the receiving pipeline operator or the Owner's gas supply shall be paid under pay item 12.02.

PART 2 PRODUCTS

2.01 CONTRACTOR-FURNISHED MATERIALS AND EQUIPMENT

- A. Nitrogen shall be 99.5 % pure or better with a dewpoint of -40 °F or lower, with delivery equipment whose regulation and relief suit the supply source, for purging, blowing and leak testing.
- B. Temporary conical strainers (100 mesh minimum, rated Class 600) shall be installed at the inlet of each control valve, meter run and relief valve during initial operation, with a removal plan. Strainers shall not be placed inside a meter tube; they shall be upstream of the meter inlet valve, because a strainer in the tube would disturb the flow profile the meter was calibrated with.
- C. Temporary blinds shall be spectacle or spade type, each numbered, painted a high-visibility color and logged on a blind register.
- D. Test equipment shall include a deadweight tester or pressure calibrator (0.025 % of reading or better), a temperature calibrator (0.1 °F), a HART communicator, multimeter, signal simulator, insulation resistance tester, loop calibrator, and a timer or data logger with 0.1 s resolution for stroke timing.

- E. Portable combustible gas and oxygen detectors shall be bump tested daily.
- F. The Contractor shall furnish consumables, temporary power, lighting and communications.

2.02 OWNER-FURNISHED MATERIALS AND SERVICES

- A. Certified calibration gases for the gas chromatograph (GPA 2198 blend, certified to GPA 2261) and for the moisture, hydrogen sulfide and oxygen analyzers (HOLD H-15).
- B. Vendor commissioning representatives for V-101, H-101 and BMS-150, the SK-110 ultrasonic meters, the B-101 analyzers, the B-102 PLC, RTU and UPS, G-101 and the valve actuators.
- C. The initial heater bath fluid per MEC-DS-003 and lubricants, where not in the vendor's scope, and commissioning spare parts.

PART 3 EXECUTION

3.01 SYSTEM BREAKDOWN

- A. Completion, pre-commissioning and handover shall be executed by system, with boundaries at the isolation points on the P&IDs. Table 3-1 is the minimum list; the Contractor may add subsystems with the Owner's approval.

Table 3-1: Commissioning Systems

System	Title	Principal content
SYS-01	Inlet and pig receiving	IJ-101, PR-101 and closure interlock, SDV-101 with equalizing bypass, PT-101, TT-101, XI-102, BDV-102 with RO-102, BDV-181, lines 1001 and 1002
SYS-02	Filtration	V-101, PDIT-103, LT-104, LIC-104, LCV-104, LG-104, LSHH-105, LSLL-106, SDV-106, RO-104, PSV-101, bypass 1004 (locked closed)
SYS-03	Metering	SK-110: MR-110, MR-120, FE/FT-111 and 121, FC-111 and 121, PT and TT-111 and 121, MOV-111, 112, 115, 121 and 122, FQI-110
SYS-04	Analyzers and sampling	B-101, SP-141, SDV-141, AE/AT-141, AT-142, AT-143, AT-144, SMP-146, sample conditioning, calibration gas
SYS-05	Heater and fuel gas	H-101 (6.0 MMBtu/h), BMS-150 with two diverse flame detectors, fire detector BE-213, TT-151, TIC-152 and TCV-152, LSL-154, TSHH-155, TT-156, PSV-157, HV-158A/B/C, FG-101, E-161, PCV-161, PCV-162, PSV-161, FT-163, PT-164, SDV-165
SYS-06	Flow control and OPSS	FCV-131 and 132 on NPS 12 branches, ZT-131 and 132, FIC-131, PIC-134, PT-133A/B/C, SDV-102 with equalizing bypass, TT-135, safety PLC
SYS-07	Outlet	CKV-171, SDV-103 with equalizing bypass, TSV-136, PT-172, TT-173, PI-174, IJ-102, outlet lateral 1041 and 1042
SYS-08	Vent, blowdown, drains and T-101	VS-101 (stainless, strakes, base drain valve), BDV-181, 182 and 183 with RO-181, 182 and 183, relief outlets, stainless vent header 1070 to 1077, drains 1060 and 1061, T-101, LT-191, LSHH-192, PVRV-193, FA-193, EV-193, truck loadout

System	Title	Principal content
SYS-09	Power and UPS	XF-101 interface, service entrance, automatic transfer switch, G-101 with restart time-delay relays on E-161, UH-101 and AC-102A, panelboards, 24 VDC UPS, 120 VAC 1.5 kVA UPS feeding LCV-104, lighting, grounding and lightning protection
SYS-10	SCADA and communications	Owner RTU, cellular primary and radio or satellite secondary paths, firewall, demarcation panel JB-W01 and point list (HOLD H-14)
SYS-11	Cathodic protection	Impressed-current system with deep anode well, test stations, IJ-101 and IJ-102 isolation, AC mitigation
SYS-12	Buildings, fire and gas, security	B-101 and B-102 HVAC and ventilation, FSL-208, GD-205, 206 and 207, HS-201 to HS-204, ZS-211, emergency lighting, extinguishers

3.02 SEQUENCE

A. The work shall follow this sequence, with the hold points shown:

1. MC of each system, after hydrotest, dewatering and drying under SPC-SPC-011 and reinstatement (HP-18-01).
2. Pre-commissioning of each system under 3.04, utilities first: SYS-09 power, then SYS-12 buildings, SYS-10 communications and SYS-11 cathodic protection.
3. RFC of each system (HP-18-02).
4. SAT of control and safety systems, cause-and-effect test, SIS validation and stage 3 functional safety assessment (HP-18-04 to HP-18-07).
5. Nitrogen purge and inert pressurization of the station, and leak test at nitrogen pressure, under SPC-SPC-012.
6. PSSR and RFSU (HP-18-08, HP-18-09).
7. Gas-in from the Owner's upstream lateral with SDV-103 closed, by Method A of SPC-SPC-012 (nitrogen pre-pressurization before gas) or by Method B only when the supply is at 900 psig or less and 60 °F or warmer, followed by staged pressurization and leak checks (HP-18-10). Throttling winter supply gas into an empty section cools it to about -52 °F, below the -20 °F minimum design metal temperature, which is why the method is restricted.
8. Startup of H-101 when the gas temperature requires it.
9. Measurement commissioning, witnessed by the receiving pipeline operator (HP-18-11).
10. First delivery into the trunkline after the receiving pipeline operator's release (HP-18-12).
11. The 72 hour performance test (HP-18-13).
12. Provisional acceptance (HP-18-14).

B. No gas shall enter any part of the station before RFSU is signed for the systems concerned. The OPSS (SYS-06) and the station emergency shutdown shall be validated before gas enters any section downstream of SDV-101.

C. Any blowdown during commissioning shall be made one section at a time, because vent stack VS-101 is sized for a single section.

3.03 MECHANICAL COMPLETION

A. MC checklists by discipline and equipment type shall confirm at least the following:

1. The installation matches the latest construction drawings and P&IDs, verified by a line-by-line and tag-by-tag walk-down by the Contractor with the Owner.
2. Hydrotest, NDE and heat treatment records are accepted and the test package is closed under SPC-SPC-011.
3. Temporary supports, test blinds, vents and drains are removed or logged on the blind register.
4. Flange joints are assembled and tagged with torque records under the flange management requirements of SPC-SPC-006.
5. Supports, guides and anchors are installed, the pipe is free to move at guides, and no pipe rests on temporary supports.
6. Valves are the correct type, rating and orientation (check valve flow arrows), with locks and car seals as the P&IDs show and operators accessible.
7. Relief valves carry set pressure tags and bench-test certificates dated within 6 months of installation, with inlet and outlet isolation valves car-sealed open.
8. Insulating joints IJ-101 and IJ-102 have been tested for isolation before and after welding in, under SPC-SPC-015.
9. Electrical insulation, continuity and grounding tests are complete and hazardous-location seals poured and inspected, under SPC-SPC-013.
10. Instruments are installed to the hook-ups, tubing leak tested, tagged and calibrated, under SPC-SPC-014.
11. Painting and coating are complete or listed as Category B punch; nameplates, tags and line markers are installed.

B. Punch lists shall be walked jointly by the Contractor and the Owner. Each item shall carry a unique number, system, category, responsible party, target date and photograph. The EOR shall attend the MC walk-downs of SYS-01, SYS-02, SYS-06 and SYS-07.

C. The MC certificate for a system shall be signed by the Contractor and the Owner when no Category A items remain and all MC records are in the database.

3.04 PRE-COMMISSIONING

A. Cleaning, flushing and blowing:

1. After drying, lines that were not pigged shall be blown with dry air or nitrogen at no less than 100 ft/s at the discharge until a white target plate exposed for 5 minutes shows no more than 3 particles larger than 1/32 in and no rust staining. Control valves, ultrasonic meters, ball valve seats and relief valves shall be removed or protected by spools during blowing.

2. Instrument and analyzer tubing shall be blown with dry nitrogen. Sample line 3/8"-G-1080-T1 shall then be leak tested with nitrogen at 1.1 times the maximum sample pressure, with zero bubbles in 1 minute at each fitting (or a helium test).
 3. Fuel gas piping downstream of PCV-161 and PCV-162 shall be purged and leak tested under NFPA 54 inside buildings and under SPC-SPC-011 elsewhere.
 4. V-101 filter elements shall not be installed until blowing is complete. The first set may be a commissioning set, with a second set supplied for replacement after the performance test.
- B. Reinstatement: every component removed for testing or blowing (ultrasonic meters, control valve trims, relief valves, instruments, restriction orifices, flow conditioners) shall be reinstated with new gaskets, tightened under SPC-SPC-006, recorded on the reinstatement register, and leak tested at nitrogen pressure during inert pressurization.
- C. Calibration verification and loop checks:
1. Every instrument in INS-LST-001 shall have a calibration record under SPC-SPC-014. OPSS transmitters PT-133A/B/C shall be recalibrated in place, as-found and as-left, at 0, 25, 50, 75 and 100 % of range and at the 1,225 psig trip point, with as-left error within the accuracy in SAF-SRS-001 (typically 0.1 % of span).
 2. Every I/O point in INS-LST-002 shall be loop checked from the field device to the operator display and, where applicable, to demarcation panel JB-W01. Analog loops shall be injected at 0, 50 and 100 % and read within 0.25 % of span; discrete loops shall be actuated or simulated at the terminal and their state, alarm text and time stamp verified; outputs shall be commanded and the field response verified.
 3. Each loop sheet (QF-18-03) shall be signed by the Contractor's technician and the Owner's instrument representative. Loops feeding the demarcation panel shall be witnessed by the receiving pipeline operator (HOLD H-14).
- D. Motors: rotation shall be verified uncoupled for every motor, including fans, HVAC units and valve actuators (direction of travel equals command). Insulation resistance of 480 V motors at 1,000 VDC shall be at least 100 megohm corrected to 40 °C. Fans shall run for 1 hour at no load with vibration within vendor limits.
- E. Valve and actuator stroke tests: every actuated valve shall be stroked from the control system, not only locally, at zero differential pressure, and timed with a calibrated timer or controller time stamps, to Table 3-2.

Table 3-2: Valve and Actuator Stroke Tests

Valve	Test	Acceptance
SDV-101, SDV-103	Close on loss of power and on loss of signal (tested separately); full open; limit switch transitions	Fails closed on each test; closing time within SAF-SRS-001; limit switch indication within 2 s of end of travel

Valve	Test	Acceptance
SDV-102 (OPSS)	Three consecutive closures from the safety PLC output, then one partial-stroke test from the safety PLC	Full closing stroke 4 s or less on each stroke, measured from PLC output de-energized to closed limit switch, with no hesitation
SDV-102 partial stroke	PST at the travel and time set in SAF-SRS-001 (typically 10 to 20 % travel), at no flow during commissioning and repeated at operating pressure after startup	Valve moves and returns within the SRS limits; diagnostic passes; no spurious closure; event logged
SDV-106	Close on LSLL-106 and LSHH-192 through the safety PLC and on station ESD	Fails closed on each trip and on loss of power
SDV-141	Close on station ESD	Fails closed
SDV equalizing bypass valves	Operation and lock status	Locked closed; on the Owner's lock register
SDV-165	Close on ESD and on BMS trip	Fails closed within 5 s (typical, vendor to confirm)
FCV-131, FCV-132	Step response 0-25-50-75-100-75-50-25-0 % with position feedback	Position error 1 % of span or less; overshoot 2 % or less; handwheel operable
MOV-111, 112, 115, 121, 122	Open and close, torque and limit settings, double block and bleed check	Full travel; no flow at the body bleed within 5 minutes with both seats closed under nitrogen
LCV-104	Stroke on command; close on LSLL-106 and LSHH-192	Closes on each trip
Burner fuel valve	Stroke on TIC-152; close on BMS trip	Closes on BMS trip

Note 1: The 4 s limit on SDV-102 comes from PRO-CAL-009. With the trip at 1,225 psig, a 1,440 psig source and both control valves wide open, a 4 s stroke holds the peak trunk pressure to 1,260 psig, 30 psi below the 1,290 psig accumulation limit, and the 5.0 s response fits within the 8.9 s process safety time.

F. Seat leakage of SDV-101, SDV-102 and SDV-103 shall be verified at nitrogen pressure during inert pressurization, by downstream pressure rise over 15 minutes within the API 6D leakage rate for the valve's specified class, or by zero bubbles at a downstream vent, whichever SAF-SRS-001 requires for SDV-102 tight shutoff.

G. Electrical energization: before any circuit is energized, insulation resistance, continuity, polarity, phase rotation, ground resistance, protective device settings per ELE-DWG-001 and arc flash labels shall be complete. Energization shall be under LOTO control with a written energization permit. Transfer to G-101 and retransfer shall be tested under load. Each UPS (24 VDC and 120 VAC) shall run on battery at design load for 30 minutes, and its discharge curve shall project at least 8 hours at design load; a full 8 hour discharge test is at the Owner's option.

H. Cathodic protection: under SPC-SPC-015, the isolation of IJ-101 and IJ-102 shall be verified, the system energized only after the outlet lateral is backfilled and connected, and native and

polarized potentials recorded. The commissioning survey may be completed after gas-in but before PA.

3.05 FACTORY AND SITE ACCEPTANCE TESTING

A. FAT and SAT shall cover at least the scope in Table 3-3. FAT is a witness point for the Owner, and a failed FAT item shall be corrected and retested before shipment.

Table 3-3: FAT and SAT Scope

Package	FAT scope	SAT scope
Safety PLC (OPSS and ESD)	Full application logic against INS-LST-004 and SAF-SRS-001 with simulated I/O; 2oo3 voting with each transmitter faulted in turn; diagnostics; bypass logic; timing; power supply redundancy; security settings; firmware recorded	Hardware installed, I/O verified by loop checks, checksum matches FAT, communication to RTU and display, then SIS validation (3.07)
RTU and operator display	Point database, alarms, trends, SCADA protocol, demarcation point list (HOLD H-14), cybersecurity hardening per API 1164	End-to-end tests to Owner gas control on both paths; failover within 60 s; point-to-point to JB-W01
Flow computer FQI-110	Configuration against MEA-DS-008 (base conditions 14.73 psia and 60 °F, atmospheric 14.10 psia, meter factors, audit trail per API 21.1); calculation check against an independent calculation at 3 flow points within 0.01 %	Live inputs from meters, transmitters and the chromatograph; archive retrieval; time synchronization; data link to the receiving pipeline operator
Analyzers in B-101	Each analyzer calibrated with certified gases; chromatograph repeatability over 10 analyses of calibration gas, heating value within 0.05 % (typical, HOLD H-15); HVAC, gas detection, lighting	Recalibration with site gases; sample system leak test and lag time (target 3 minutes or less per MEA-CAL-004); communication to FQI-110 and RTU
Ultrasonic meters FE-111, FE-121	Flow calibration at an accredited facility with meter tube and conditioner at 7 or more flow rates; certificate and as-left factors; diagnostic baseline	Zero-flow verification (3.10), diagnostic comparison, configuration checksum against the calibration certificate
BMS-150 and H-101 controls	Flame safeguard sequence, purge, ignition trial, flame failure response, all trips	Per 3.08
UPS and panelboards	Vendor standard FAT with battery capacity report	Autonomy test per 3.04 G

3.06 CAUSE-AND-EFFECT FUNCTIONAL TESTING

A. Every cause and every effect in INS-LST-004 shall be tested from the field initiating device, not by forcing in software, except where the approved procedure justifies simulation at the transmitter (for example injecting a calibrated pressure at PT-133A/B/C rather than pressurizing the line).

B. The functions tested shall include at least: station ESD from each of HS-201 to HS-204; high-high gas at GD-205, 206 and 207; BMS fire trip; loss of 24 VDC control power; the receiving

pipeline operator's remote shutdown command, simulated at the demarcation panel and witnessed by the receiving pipeline operator; LSHH-105 closing SDV-101; LSHH-192 and LSLL-106 closing LCV-104 and SDV-106; FSL-208 alarm; utility failure and transfer; the gas quality shut-in sequence (FIC-131 ramped to zero, then SDV-103 closed after the configured delay); the PIC-134 low-select override; and duty-standby control valve switchover on position deviation.

- C. Each test record shall show the initiating action, expected effect, actual effect, time to effect, alarm and event records, and reset behavior. Reset shall require the local and remote actions specified; nothing shall restart automatically.
- D. Every effect shall occur as
INS-LST-004 specifies. Any deviation is a Category A punch item.

3.07 SIS VALIDATION AND FUNCTIONAL SAFETY ASSESSMENT

- A. Validation under IEC 61511-1 Clause 15 shall demonstrate that the installed SIS meets
SAF-SRS-001 for every SIF identified in
SAF-RPT-002 and
SAF-CAL-001. The OPSS function, SIF-01, is SIL 2: transmitters PT-133A/B/C on separate safety PLC input cards, 2oo3 voting, trip at 1,225 psig, closing SDV-102 and SDV-103. The BMS function, SIF-05, is also SIL 2, with two diverse flame detectors and a SIL 2-certified BMS; the heater gas outlet high-high trip on TT-156 is set at 140 °F.
- B. The validation of each SIF shall include:
 - 1. Each sensor checked with a calibrated pressure source of 0.025 % of reading accuracy, with the as-found trip value recorded.
 - 2. Voting: with one transmitter at trip, no trip and an alarm; with two at trip, SDV-102 and SDV-103 close. Each of the three pairs (A and B, B and C, A and C) shall be tested.
 - 3. Degraded mode: one transmitter failed low, failed high and bad quality in turn, with voting degrading as the SRS specifies (typically to 1oo2) and an alarm raised.
 - 4. Response time from the second transmitter crossing 1,225 psig to SDV-102 closed, within the process safety time allocation in the SRS; SDV-102 full stroke 4 s or less.
 - 5. Input card separation: the as-built I/O assignment checked against
INS-LST-002, and one card pulled at a time with the SIF continuing on the remaining transmitters with an alarm. This is required because a common card would defeat the 2oo3 architecture.
 - 6. The SDV-102 partial-stroke test from the safety PLC, its diagnostic coverage as credited in
SAF-CAL-001, and the quarterly test procedure.
 - 7. SDV-102 closing on loss of power to its solenoid and on safety PLC fault.
 - 8. Manual shutdown from the safety PLC and from HS-201 to HS-204.
 - 9. Reset only by deliberate operator action after the trip condition clears, with no automatic reopening.
 - 10. Independence from the basic process control system, by disconnecting its network and confirming that the OPSS still trips.

- C. Bypass management shall be tested for each PT-133 input: bypass alarm and event log, only one transmitter in bypass at a time, and automatic bypass time-out if specified. No bypass of SDV-102 shall exist other than the mechanical bypass valves on the P&IDs, which shall be locked closed and on the Owner's lock register.
- D. The Contractor's SIS integrator shall draft, and demonstrate once during validation, the proof test procedure for each SIF, with the proof test interval from SAF-RPT-002 and SAF-CAL-001, the quarterly SDV-102 partial-stroke test, the test coverage, as-found and as-left recording and restoration steps. The procedure becomes part of the operating procedures in CON-RPT-004.
- E. The stage 3 functional safety assessment under IEC 61511-1 5.2.6.1 shall be performed after validation and before gas is introduced, by an assessor independent of the design and installation teams and appointed by the Owner. The EOR shall review and co-sign it. It is a hold on RFSU.
- F. The validation report shall record every step, the test equipment and calibration dates, the software version and checksum, the bypass register, and all deviations with their closure.

3.08 LINE HEATER AND BURNER MANAGEMENT STARTUP

- A. Prerequisites: SYS-05 at RFC; bath filled to the vendor level; LSL-154 verified; firebox, stack and burner inspected; fuel gas piping purged and leak tested; PSV-157 installed and car-sealed; area gas-free (0 % of the lower flammable limit) around the firebox.
- B. Before light-off, the BMS purge timer, ignition trial timing, flame failure response (loss of flame to fuel valve closed within 4 s, typical, vendor to confirm, per API RP 556 guidance) and each trip (LSL-154, TSHH-155, TT-156 high-high, low and high fuel pressure, ESD, SDV-165 closure) shall be shown to close the burner fuel valve.
- C. Light-off and heat-up shall follow the vendor's curve, typically a bath rise of no more than 50 °F/h.
- D. Stack oxygen and carbon monoxide shall be measured with a calibrated combustion analyzer at low and high fire and set per the vendor (typically 3 to 6 % oxygen and carbon monoxide below 200 ppm; HOLD H-15). The fuel rate on FT-163 shall be recorded.
- E. The outlet temperature control shall be verified in cascade from TT-135, holding the control valve outlet at the pressure-compensated setpoint in INS-RPT-001 and never below 40 °F.
- F. If gas temperatures do not require heating at startup, the Owner may defer heater startup to the first cold season. The Contractor shall then complete all tests up to a 4 hour hot run and return for final tuning, within pay item 18.02.

3.09 PRE-STARTUP SAFETY REVIEW

- A. The Contractor shall support the PSSR and provide the evidence for it. The PSSR checklist shall confirm at least:
 - 1. MC certificates for all systems.

2. HAZOP (SAF-RPT-001) and LOPA recommendations closed or covered by approved interim measures.
3. Management of change items raised during construction closed, including P&ID updates.
4. SIS validated and the stage 3 assessment signed.
5. Relief valves installed, set and car-sealed; locks and car seals per the lock register.
6. Operating and maintenance procedures under 49 CFR 192.605 issued, emergency procedures under 192.615 in place, and local emergency responders notified.
7. Operators trained and qualified for their covered tasks under 49 CFR 192 Subpart N.
8. Extinguishers, gas detectors and signage installed.
9. The hazardous area classification (ELE-RPT-001 and ELE-DWG-002) matches the field.
10. The receiving pipeline operator's release obtained for gas-in to the tie-in section.
11. Records for the maximum allowable operating pressure complete under SPC-SPC-020 for the sections to be pressurized.

B. PSSR items shall be classified as prior to startup (holding RFSU) or post startup (tracked to PA).

3.10 MEASUREMENT COMMISSIONING

- A. Measurement commissioning shall be performed by the Owner's measurement technician with Contractor support, witnessed by the receiving pipeline operator on 72 hours' notice.
- B. Every flow computer parameter shall be compared with MEA-DS-008 and the meter calibration certificates, and the configuration report printed and signed with zero discrepancies.
- C. PT-111, PT-121, TT-111 and TT-121 shall be verified in place against reference standards: pressure at 0.025 % of reading, and temperature within 0.2 °F of a reference in test wells TW-112 and TW-122.
- D. Ultrasonic meter zero-flow verification (AGA 9 guidance) shall be attended at all times, with the meter run blocked in only for the duration of the test, because a run blocked in at both ends in sun can reach about 1,570 psig. Otherwise the standby run shall be kept pressurized with its outlet valve open. With the run pressurized and thermally stable for at least 30 minutes, at least 30 minutes of data shall be recorded. The mean velocity on each path shall be within the vendor's zero-flow limit (typically 0.02 ft/s; HOLD H-15), the speed of sound spread across paths within the vendor limit (typically 0.2 %), and the measured speed of sound within 0.2 % of the AGA 10 value calculated from the live composition (0.3 % if nitrogen is used).
- E. A diagnostic baseline (signal-to-noise ratio, gain, path performance, profile factor, symmetry and swirl) shall be recorded at up to three flow rates as the reference for condition monitoring.
- F. The chromatograph shall be calibrated with the certified standard per GPA 2261, with 5 consecutive verifications: response factor repeatability and unnormalized total within vendor limits (typically 99.5 to 100.5 %), and the heating value of the standard within 0.1 % of its

certified value. The moisture, hydrogen sulfide and oxygen analyzers shall be verified with span gases within vendor accuracy.

- G. Once stable flow is available, meter runs MR-110 and MR-120 shall be placed in series through MOV-115 per MEA-PRC-001, at flows no higher than those of normal operation, for at least 1 hour at each available flow rate. The meters shall agree within 0.3 %; if they do not, both shall be investigated before custody delivery continues.
- H. Composite sampler SMP-146 grab volume and flow-proportional pacing shall be verified.
- I. The Owner and the receiving pipeline operator shall sign the measurement commissioning record QF-18-08. This is a hold before custody delivery.

3.11 INITIAL STARTUP AND FIRST DELIVERY

- A. The station shall be pressurized from upstream with SDV-103 closed. Pressure shall be equalized across SDV-103 through its equalizing bypass only with the receiving pipeline operator's release and under SPC-SPC-012.
- B. Initial flow shall be at a low rate (10 MMSCFD or less, case C3) for at least 4 hours, with all joints leak checked by portable detector and soap at pressure, and control valve vibration and noise checked.
- C. Temporary strainers shall be removed after 72 hours of stable operation, or when their differential pressure exceeds 5 psi, whichever is earlier, under isolation and blowdown, and the joints reinstated with new gaskets and leak tested.
- D. Flow shall be ramped to the nominated rate in steps agreed with the receiving pipeline operator's gas control.

3.12 PERFORMANCE TEST

- A. After first delivery and measurement acceptance, the Contractor shall support a continuous 72 hour performance test at the maximum flow available from the Owner's supply (target 120 MMSCFD). The test is valid at no less than 50 % of design flow if supply is limited, with a retest at higher flow within 12 months within pay item 18.02.
- B. Data shall be recorded at 1 minute intervals from the SCADA historian, and the acceptance criteria in Table 3-4 shall be met.

Table 3-4: Performance Test Acceptance Criteria

Parameter	Criterion	Method
Continuous operation	72 h with no trip, SIS demand or unplanned shutdown caused by the Work	Event log
Flow control	Within 1 % of setpoint at steady state	FIC-131 trend
Outlet pressure	Never above 1,150 psig	PT-134, PT-172 trends

Parameter	Criterion	Method
Control valve outlet temperature	At or above the control setpoint and never below 40 °F	TT-135 trend
Filter separator differential	3 psi or less (2 psi clean plus 1 psi)	PDIT-103
Station pressure drop excluding the control valve	20 psi or less, scaled to 120 MMSCFD	Pressure trends
Ultrasonic meter diagnostics	All paths healthy, performance 95 % or higher, no alarms	Meter diagnostics
Meter agreement	Within 0.3 % if a series check is run	Series verification
Chromatograph and analyzers	No failure; calibration verification passes at the end; readings valid and within the tariff	Analyzer reports
Heater (if in service)	Bath within 5 °F of setpoint; no BMS trip	TT-151
Leaks	None detectable at 500 ppm or by bubble test at the start and end	Leak survey
Vibration and noise	Piping vibration within MEC-CAL-004 limits; noise at 3 ft within 85 dBA or the control valve datasheet value	Handheld meter
Data	The receiving pipeline operator receives all demarcation points with no gap over 5 minutes	Operator confirmation

C. A failure caused by the Work shall be corrected and the full 72 hour test repeated.

3.13 HANDOVER CERTIFICATES

A. Handover shall proceed through the certificates in Table 3-5.

Table 3-5: Handover Certificates

Certificate	Prerequisites	Signatories
MC, per system	3.03 complete; no Category A punch	Contractor, Owner (EOR for SYS-01, 02, 06, 07)
RFC, per system	Pre-commissioning complete; loop checks, stroke tests and energization tests signed; Category A items from pre-commissioning closed	Contractor, Owner
RFSU, station	SAT and cause-and-effect test complete; SIS validation and stage 3 assessment signed; PSSR prior-to-startup items closed; gas-in procedure approved; receiving pipeline operator's release for work affecting its facilities	Contractor, Owner, EOR, receiving pipeline operator for the tie-in section
PA	Performance test passed; measurement commissioning accepted; Category B list agreed with dates; dossier and records accepted under SPC-SPC-020; training delivered	Contractor, Owner, EOR

Certificate	Prerequisites	Signatories
Final acceptance	All Category B and C closed; final as-builts accepted; warranty period started	Contractor, Owner

B. Care, custody and control of each system shall pass to the Owner at RFC for commissioning purposes. The Contractor remains responsible for defects and for its own work under Owner permits.

3.14 TRAINING, VENDOR REPRESENTATIVES AND SAFETY

A. The Contractor shall coordinate classroom and field training for the Owner's operators and technicians: station overview and P&ID walk (8 h); control and SIS operation including bypasses and resets (8 h); measurement systems (16 h, by vendors); heater and BMS (4 h, by vendor); electrical, UPS, G-101 and transfer switch (4 h); cathodic protection (2 h); and emergency response and ESD (4 h). Classes shall have no more than 8 attendees, with two sessions per module to cover shift crews, and training records shall be delivered for the Owner's operator qualification files.

B. Vendor representatives shall receive 14 days' notice and a weekly 3-week look-ahead, and their attendance days shall be recorded. At minimum, the meter vendor shall attend zero-flow verification and first flow, the chromatograph vendor SAT and first calibration, the heater vendor startup, the safety PLC integrator SAT and validation, the actuator vendor the SDV-102 stroke tests, and the generator vendor the transfer tests. Standby caused by the Contractor's unreadiness shall be at the Contractor's cost.

C. Commissioning work shall follow CON-RPT-003 and the Owner's permit-to-work system. A section containing nitrogen above 50 psig or any gas is live, and all work on it requires an Owner permit, LOTO, isolation certificates and gas testing. Nitrogen asphyxiation hazards at vents and in B-101 and B-102 shall be controlled with oxygen monitors alarming at 19.5 %.

3.15 FIELD QUALITY CONTROL

A. The hold and witness points in Table 3-6 apply. Party codes: C Contractor, O Owner, E EOR, W receiving pipeline operator; H hold, W witness, R review, S surveillance, P perform.

Table 3-6: Hold and Witness Points

ID	Activity	C	O	E	W	Record
HP-18-01	Mechanical completion per system	P	H	R	-	QF-18-01 MC certificate and checklists
HP-18-02	Ready for commissioning per system	P	H	R	-	QF-18-02 RFC certificate
WP-18-01	FAT of safety PLC, RTU, FQI-110, B-101 analyzers, BMS-150	S	W	W	W	Vendor FAT report

ID	Activity	C	O	E	W	Record
HP-18-03	Loop checks complete, including demarcation panel points	P	H	-	W	QF-18-03 loop sheets
WP-18-02	Valve stroke tests, SDV-102 full stroke 4 s or less and partial-stroke test	P	W	W	W	QF-18-04 stroke test record
HP-18-04	SAT of safety PLC, RTU, flow computer, analyzers, ultrasonic meters	P	H	R	W	QF-18-05 SAT records
HP-18-05	Cause-and-effect functional test	P	H	W	W	QF-18-06 test record
HP-18-06	SIS validation: SIF-01 OPSS SIL 2 (2oo3 at 1,225 psig on separate input cards, closes SDV-102 and SDV-103, PST demonstrated), SIF-05 BMS SIL 2, bypass tests	P	H	H	W	QF-18-07 SIS validation report
HP-18-07	Stage 3 functional safety assessment before gas is introduced	S	H	H	R	Assessment record
HP-18-08	PSSR prior-to-startup items closed	S	H	R	-	PSSR checklist
HP-18-09	RFSU certificate	P	H	H	H	RFSU certificate
HP-18-10	Gas-in and staged pressurization of the station	P	H	S	W	Gas-in record (SPC-SPC-012)
WP-18-03	H-101 BMS trips and light-off	P	W	-	-	Heater startup record
HP-18-11	Measurement commissioning and first series verification within 0.3 %	S	H	R	H	QF-18-08 measurement record
HP-18-12	First delivery into the trunkline	S	H	-	H	Operator release, delivery log
HP-18-13	72 hour performance test	P	H	R	W	QF-18-09 performance test report
HP-18-14	Provisional acceptance	P	H	H	-	PA certificate

3.16 ACCEPTANCE

A. Commissioning is accepted at PA when the criteria in Table 3-7 and Table 3-4 are met and the certificates in Table 3-5 are signed.

Table 3-7: Commissioning Acceptance Criteria

Parameter	Criterion	Method
Line cleanliness	3 or fewer particles larger than 1/32 in on the target plate in 5 min; no rust staining	Target plate

Parameter	Criterion	Method
Tubing leak test	Zero bubbles in 1 min per fitting at 1.1 times maximum sample pressure	Bubble or helium test
Analog loop accuracy	Within 0.25 % of span at 0, 50 and 100 %	Loop check
OPSS transmitter calibration	As-left within the SRS accuracy (typically 0.1 % of span), including at 1,225 psig	Deadweight tester or calibrator
SDV-102	Full stroke 4 s or less on three consecutive strokes; partial-stroke test passes within SRS limits	Timed from PLC output; PST diagnostic
Shutdown valve fail-safe	Closes on loss of power and on loss of signal	Stroke test
OPSS voting	Trips on any 2 of 3 at 1,225 psig; no trip on 1 of 3	SIS validation
Cause and effect	100 % of causes and effects tested, zero deviations	Functional test
BMS flame failure	Fuel valve closed within the vendor time (typically 4 s)	Timed test
Meter zero flow	Within vendor limits (typically 0.02 ft/s per path)	30 min record
Speed of sound	Measured within 0.2 % of the AGA 10 value	Meter and flow computer
Series meter verification	Agreement within 0.3 %	Series test
Chromatograph	Heating value of the standard within 0.1 % of certified	Calibration verification
UPS autonomy	Projection of 8 h or more at design load from a 30 min test, for both UPS	Discharge test
Insulation resistance, 480 V motors	100 megohm or more at 1,000 VDC	Insulation tester
Performance test	All criteria in Table 3-4 met for 72 h	Historian review

END OF SECTION