

SCOPE

- I 1.1 This practice covers the design of machine and auxiliary system instrumentation and panels for compressors and drivers. It also delineates the responsibilities of the machinery vendor and the Owner in supplying the instrumentation.
- I 1.2 **An asterisk (*)** indicates that either a decision by the Purchaser is required, that additional information is to be furnished by the Purchaser, or that information for Purchaser approval is to be supplied by the Vendor or Contractor.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I 2.1 **Table 1** lists the practices which shall be used with this practice.

TABLE 1

PRACTICES			
IP 3-6-1	Piping for Instruments	IP 15-4-1	Flow Instruments
IP 10-12-1	Vibration, Axial-Position, and Bearing-Temperature Monitoring Systems for Compressors and Drivers	IP 15-5-1	Level Instruments
IP 10-14-1	Lube and Seal Oil Systems for Machinery	IP 15-6-1	Electronic and Pneumatic Instruments
IP 14-3-1	Fireproofing	IP 15-6-2	Environmental Protection for Instrumentation
IP 15-2-1	Temperature Instruments	IP 15-7-2	Protective Systems
IP 15-3-1	Pressure Instruments	IP 15-7-3	Alarm Systems
		IP 15-9-1	Control Valves
		IP 15-10-1	Instrument Transmission Systems

- I * 2.2 **Table 2** lists the practices which shall be used with this practice as specified by the Purchaser.

TABLE 2

PRACTICES			
IP 15-7-1	Electric Power Branch Circuit Design for Instrumentation	IP 15-11-1	Instrument Control Panels

DEFINITIONS

- I 3.1 **Locally mounted instruments** are those which are mounted on or near the machinery, at or near piping, but not on panels, and include switches, transmitters, thermocouples, and gages.
- I 3.2 **Local panels** are those which provide mounting for all indicating instruments and controllers for process and auxiliary system variables which the operator requires for placing the machine in process service.
- I 3.3 **Control house operating consoles** are panels in the main control house which are used for overall process operation.
- I * 3.4 **Critical services** are those where a lifecycle evaluation of an unsparred compressor installation has shown that the costs associated with a compressor outage justify the added costs of redundant field instrumentation and logic systems with TMR architecture. Critical services shall be specified.
- I 3.5 Triple Modular Redundant (TMR) architecture describes an integrated fault tolerant programmable logic system composed of three isolated parallel subsystems (triplicated central processing units, triplicated communication paths, and input/output modules whose module design contains triplicated data handling circuits). Two-out-of-three voting is performed at each part of the system, where possible. TMR logic systems may be used with either single or redundant field sensors.

DESIGN

- I 4.1 **Tables 3 through 8** list the instrumentation to be supplied, the mounting location, and delineate the purchaser's and vendor's areas of responsibility.
- O * 4.2 **A local panel** shall be provided by the contractor for each compressor to allow for startup and routine monitoring. Space may be required for readout instrumentation supplied by the machinery vendor.

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| R,C | 4.3 | The Purchaser shall specify the manufacturer and model for the standard instruments to be supplied by machinery vendors. To the maximum extent possible, they shall be the same as used in the rest of the plant. Instruments shall be in accordance with IP 15-6-1 and IP 15-6-2 . |
| I | 4.4 | Temperature instruments shall be in accordance with IP 15-2-1 . |
| I | 4.5 | Pressure instruments shall be in accordance with IP 15-3-1 . |
| O | 4.6 | Pressure instruments shall be mounted near the sensing point elevation to eliminate the need for head compensation of readings or setpoints. |
| I | 4.7 | Flow instruments shall be in accordance with IP 15-4-1 . |
| I | 4.8 | Level instruments shall be in accordance with IP 15-5-1 . |
| S,R | * 4.9 | Protective systems shall be in accordance with IP 15-7-2 . In addition, the following requirements shall apply to automatic start-up and shutdown systems: <ul style="list-style-type: none"> a. Automatic start-up systems (e.g., spare oil pump cut-in) shall be designed as protective systems and may be integrated with the protective systems. * b. The design of protective circuits shall be "Fail-No-Action" per IP 15-7-2. Automatic start-up circuits, however, shall be designed "Fail-Action." Exceptions shall be approved by the Owner's Engineer. * c. Automatic start-up and shutdown systems for critical services shall be implemented using TMR logic systems. Sensor and end element redundancy and associated voting requirements are specified in Tables 3A or 5A as applicable. * d. The sensor and end element redundancy and voting requirements for critical initiators will be specified by the Owner's Engineer. e. Redundant protective system sensors shall have their own separate taps/isolation valves or wells to facilitate on-line testing or maintenance. f. Design of all automatic start-up and shutdown circuits shall include provisions for on-line testing of each component of the system without affecting process operations. |
| O,R | 4.10 | Upon instrument air or electrical power failure, regulating devices including governors shall fail in a position which insures continued safe operation of the compressor and driver. The design shall provide the operator with a manual shutdown operation from the local panel and the control house.

Manual trip initiators shall be designed to remain operable regardless of a failure of the protective system logic. These manual trip initiators shall also be input to the protective system logic and shall be fireproofed per IP 14-3-1 . |
| O | 4.11 | Alarms shall be in accordance with IP 15-7-3 . One common annunciator shall be furnished for each compressor. The local panel alarms on each compressor service (compressor, gear, driver) shall actuate common alarms in the control house to call the (Control House) operator's attention to an alarm condition at the machine. |
| O | * 4.12 | When specified by Purchaser, instrumentation designated as located on the local panel may selectively or totally be located or duplicated in the control house. |

Revision Memo

1/71	Revision 1	1/83	Revision 5
6/71	Revision 2	6/86	Revision 6
1/79	Revision 3	6/88	Revision 7
6/81	Revision 4	12/92	Revision 8
6/96	Revision 0 - Original Issue of International Practice		
3/98	Revision 1		
	This is a reaffirmation of Revision 0, June 1996, with only minor editorial changes.		

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ABBREVIATIONS FOR FUNCTIONAL HARDWARE (TABLES 3 THROUGH 8)

LETTERS	VARIABLE TYPES	FUNCTION CODES		
		POSITION - 1	POSITION - 2	POSITION - 3
A		Alarm	Alarm	Alarm
B	Burner Flame			
C		Controller or Control	Controller or Control	
(CI)			Cut In	
(CO)		Cut Out	Cut Out	Cut Out
D			Dial	
d		Differential		
E		Element (Primary)	Element (Primary)	
F	Flow			
G		Gage		
H	Hand Actuated	High	High	
I	Current	Indicating or Indicator	Indicating or Indicator	
L	Level	Low	Low	
P	Pressure	Phase		
R	Remote	Recording or Recorder		
S	Speed	Switch	Switch	
T	Temperature	Transmitter	Transmitter	
(TC)	Thermocouple			
V	Vibration		Valve	Valve
W		Well		
Z	Position (Displacement)			

ABBREVIATIONS FOR MOUNTING LOCATION (TABLES 3 THROUGH 8)

LETTERS	
Brg	Bearing
CH	Control House Panel
D	Drum
GB	Gage Board
LP	Local Panel
Ma	Machine
P	Piping
SP	Gas Seal Panel
T	Lube and Seal Oil Reservoir Overhead Seal Oil Tank } as indicated

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TABLE 3
INSTRUMENTATION FOR CENTRIFUGAL, AXIAL AND (DRY) ROTARY SCREW COMPRESSORS

SYSTEM	EQUIPMENT	BY VENDOR		BY PURCHASER	
		FUNCTIONAL HARDWARE (QUANTITY AS INDICATED)	MOUNTING LOCATION	FUNCTIONAL HARDWARE	MOUNTING LOCATION
Lube Oil System	Oil Reservoir	TW & TID LG LS LS*	T T T T	— — LLA LHA*	— — LP LP
	Oil Pump-Standby	PL(CI) & PLCV PI & PS	P P	— PHA	— LP
	Oil Pump-Main	PI	P	—	—
	Pump Discharge Header	PCV PI TW & TID	P P P	— — —	— — —
	Oil Coolers - Oil Outlet	TW & (TC) TW & TID TCV	P P P	THA, TI — —	LP Note 1 — —
	Oil Filter	PdI PdS	P P	— PdHA	— LP
	Accumulator, Direct Contact Type	PI (Charge Gas) LG LS LS LS & LLCV	P T T T T & P	— — LHA LLA —	— — LP LP —
	Oil Supply Header	PI PS PS (One)	P P P	— PLA PLL(CI), PLL(CI)A	— — LP Note 2
	Lube Oil Header	PCV PI PS PS (One)	P P P P	PI — PLA PLL(CO)A & PLL(CO)	LP — LP LP Note 3
	Compressor Drains, Each Bearing	FI (Sight Glass) TW & TID	P P	— —	— —
	Coupling Housing Drain	FI (Sight Glass)	P	—	—
Control Oil System	Control Oil Header	PCV (If Applicable) PI PS	P P P	— PI PLA	— LP LP
Seal Oil System	Oil Reservoir	TW & TID LG LS	T T T	— — LLA	— — LP
	Oil Pump - Standby	PI (Two) & PS	P	PHA	LP
	Oil Pump - Main	PI (Two)	P	—	—
	Oil Coolers - Oil Outlet	TW & (TC) TCV TW & TID	P P P	TI, THA — —	LP Note 5 — —
	Oil Filter	PdI PdS	P P	— PdHA	— LP

TABLE 3 (Cont)
INSTRUMENTATION FOR CENTRIFUGAL, AXIAL AND (DRY) ROTARY SCREW COMPRESSORS

SYSTEM	EQUIPMENT	BY VENDOR		BY PURCHASER	
		FUNCTIONAL HARDWARE (QUANTITY AS INDICATED)	MOUNTING LOCATION	FUNCTIONAL HARDWARE	MOUNTING LOCATION
	Head Tank, Each Casing (If Applicable)	LC LCV LG LS (One) LS (One) LS (One)	T P T T T T	— — — LHA LLA, LL (CI), LL (CI)A LLL (CO) & LLL (CO)A } Note 4	— — — LP LP Note 2 LP Note 3
	Seal Oil Header	PCV (If Applicable) PI	P P	PI —	LP —
	Seals/Buffered Labyrinths	PdI & PdS	P	PdA	LP
	Atmospheric Drain	FI (Sight Glass) TW & TID	P P	— —	— —
	Drain Trap (If Applicable)	LG LC & LCV	P P	— —	— —
Compressor Dry Gas Seals Figure 1: Unpressurized Dual (Tandem) Seal Design w/o Internal Labyrinth	Buffer Gas Filtration	PdT PdI	P SP	PdHA —	LP —
	Buffer Gas Header Pressure Control	PCV PI, TW & TID	P P	— —	— —
	Individual Seal Cartridge Buffer Gas Supply (IB & OB)	FE, FT PdT PdI, FI	P P SP	— PdLA, PdHA —	— LP —
	Individual Seal Primary Seal Leakage (IB & OB)	PI FE, FT (Two) FI PT	SP P SP P	— FHA *FHH (CO) & FHH (CO) A — —	— LP Notes 3 & 6 — — —
	Individual Seal Secondary Seal Leakage (IB & OB)	PI PT FE, FT FI	SP P P SP	— — — —	— — — —
	Individual Seal Outboard Separation Gas	PCV PT PI FE, FT FI	P P P, SP P SP	— PLA, PHA — — —	— LP — — —
	Primary Seal Vent vs Secondary Seal Vent Differential Pressure	PdI	SP	PdLA	LP
Compressor Dry Gas Seal Figure 2: Unpressurized Dual (Tandem) Seal Design with Internal Labyrinth	Buffer Gas Filtration	PdT PdI	P SP	PdHA —	LP —
	Buffer Gas Header Pressure Control	PCV PI, TW & TID	P P	— —	— —
	Individual Seal Cartridge Buffer Gas Supply (IB & OB)	FE, FT PdT PdI, FI	P P SP	— PdLA, PdHA —	— LP —

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SYSTEM	EQUIPMENT	BY VENDOR		BY PURCHASER	
		FUNCTIONAL HARDWARE (QUANTITY AS INDICATED)	MOUNTING LOCATION	FUNCTIONAL HARDWARE	MOUNTING LOCATION
	Individual Seal Primary Seal Leakage (IB & OB)	PI FE, FT (Two) FI PT	P P SP P	FHA, *FHH(CO) & FHH(CO)A — —	LP Notes 3, 6, 7 — —
	Individual Seal Secondary Seal Leakage (IB & OB)	PI PT FE, FT FI	P P P SP	— — — —	— — — —
	Purge Gas Filtration/Pressure Control	PdT PdI PCV	P SP P	PdHA — —	LP — —
	Individual Seal Purge Gas	FE, FT Note 7 PI, PT FI	P P SP	FHA, FLA PLA —	LP LP —
	Purge Gas vs Secondary Seal Vent Differential Pressure	PdI	SP	PdLA	LP
	Individual Seal Outboard Separation Gas	PCV PT PI FE, FT FI	P P P, SP P SP	— PLA — — —	— LP — — —
Compressor Dry Gas Seals Figure 3: Pressurized Dual (Double) Seal Design	Barrier Gas Filtration	PdT PdI	P SP	PdHA —	LP —
	Barrier Gas Header Pressure Control	PCV PI, TW & TID	P P	— —	— —
	Individual Seal Cartridge Barrier Gas Supply (IB & OB)	FE, FT PdT PdI, FI PdT	P P SP P	FHA PdLA — PdLL(CO) & PdLL(CO)A	LP LP — LP Note 3
	Individual Seal Secondary Seal Leakage (IB & OB)	PI FE, FT FI	P P SP	— FHA —	— LP —
	Individual Seal Outboard Separation Gas	PCV PT PI FE, FT FI	P P P, SP P SP	— DPLA, DPHA — — —	— LP — — —
Compressor Gas Stream	Suction K.O. Drum	—	—	LS (Two) LHA LHH(CO) & LHH(CO)A	D LP LP & Note 3
	Each Casing Inlet (Including Each Side Stream)	—	—	TW & TID, TW & (TC) TI PT, PI PI	P LP P LP



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SYSTEM	EQUIPMENT	BY VENDOR		BY PURCHASER	
		FUNCTIONAL HARDWARE (QUANTITY AS INDICATED)	MOUNTING LOCATION	FUNCTIONAL HARDWARE	MOUNTING LOCATION
	Each Casing Discharge (Including Each Side Stream)	—	—	TW & TID, TW & (TC) THA, TI PT, PI TI & PI	P LP P LP
	Inlet, Interstage & Discharge Motor Operated Valve (MOV)	—	—	ZS ZL(CO) ZL(CO)A	P LP Notes 3 & 8 LP
	Anti Surge System	—	—	FCV & Note 9	P
	Total Compressor Flow	— —	— —	FI FE, FT	LP P
	Recycle Flow	— —	— —	FI FE, FT	LP P
Compressor Flushing System	Flushing Header (Downstream of Strainer)	PI	P	—	—
	Flushing Strainer	PdI	P	—	—
	Flushing Lateral, Each	FI HCV	P P	— —	— —
	Collecting Drum	PI & LG	D	—	—
Vibration, Axial Position and Bearing Temperature Monitoring System	Compressor Casing Radial, Each Bearing	VE (Two) VI (One) VS Note 10 — —	Ma LP LP — —	— — VHA VHH(CO) VHH(CO)A	— — LP Note 3 LP
	Axial	ZE (Two) ZI (One) ZS Note 11	Ma LP LP	— — ZHA ZHH(CO) ZHH(CO)A	— — LP Note 3 LP
	Phase Angle	VPE (One) Note 14	Ma	—	—
	Motor Drivers Radial, Each Bearing	VE (Two) VI (One) VT Note 10	Ma LP LP	— — VHA VHH(CO) VHH(CO)A	— LP LP Note 3 LP
	Compressor Bearings Radial. Each	(TC) (Two)	Brg	TI TS, THA Note 12	LP LP
	Thrust. Active/Inactive	(TC) (Two per side min)	Brg	TI TS, THA Note 13	LP LP
Motor Drivers		—	—	H (CO) & H (CO) A	CH & LP Note 3
	Motor Windings	TE (Two) Each Phase	Ma	TI TS, THA	LP LP

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SYSTEM	EQUIPMENT	BY VENDOR		BY PURCHASER	
		FUNCTIONAL HARDWARE (QUANTITY AS INDICATED)	MOUNTING LOCATION	FUNCTIONAL HARDWARE	MOUNTING LOCATION
	Motor Bearings Radial, Each	TW & TID FI (TC) (Two)	P P Brg	— — TI, TS, THA Note 12	— — LP
	Motor Air Filters	PdI	Ma	Pd HA	LP

Notes:

- (1) Temperature monitor vendor supplies high temperature alarm relay and high temperature cut out relay for point. Cut out relays shall not be wired. Purchaser supplies panel alarm light (one per train) to indicate "High Lube Oil Temperature" alarm on local panel and all circuits required to connect high temperature relays to the machinery alarm systems.
- (2) Connected to standby pump low pressure or low level cut in.
- (3) Connected to driver shutdown system.
- (4) Action controlled by seal oil header pressures for some seal systems.
- (5) Temperature monitor vendor supplies high temperature alarm relay and high temperature cut out relay for point. Cut out relays shall not be wired. Purchaser supplies panel alarm light (one per train) to indicate "High Seal Oil Temperature" alarm on local panel and all circuits required to connect high temperature relays to the machinery alarm systems.
- (6) The primary seal high, high flow shutdown is optional.
- (7) When purge gas is specified, High Primary Seal Leakage is determined by High Flow Differential of Primary Seal Leakage to Flare vs Purge Gas Flow to the individual seal.
- (8) All Compressor Inlet interstage, and discharge MOV's shall be provided with position switches which activate the main unit cut out should the MOV move past the 50% closed position. Circuits are provided to connect the switches into the machinery alarm and trip system.
- (9) Anti surge instrumentation as specified by purchaser.
- (10) Vibration monitor vendor supplies high vibration (displacement) alarm relay and high vibration cut out relay. Purchaser supplies panel alarm light (one per train) to indicate above functions for local panel and all circuits required to connect vibration relays to machinery alarm and trip systems.
- (11) Vibration monitor vendor supplies high axial position alarm relay and high axial position cut out relay. Purchaser supplies panel alarm light (one per train) to indicate function for local panel and all circuits required to connect axial position relays to machinery alarm and trip systems.
- (12) Temperature monitor vendor supplies high temperature alarm relay and high temperature cut out relay for each radial bearing temperature point. Cut out relays shall not be wired. Purchaser supplies panel alarm light (one per train) to indicate "High Radial Bearing Temperature" alarm on local panel and all circuits required to connect high temperature relays to the machinery alarm systems.
- (13) Temperature monitor vendor supplies high temperature alarm relay and high temperature cut out relay for each thrust bearing temperature point. Cut out relays shall not be wired. Purchaser supplies panel alarm light (one per train) to indicate "High Thrust Bearing Temperature" alarm on local panel and all circuits required to connect high temperature relays to the machinery alarm systems.
- (14) Provided on train driver.



**TABLE 3A
INSTRUMENTATION FOR CENTRIFUGAL, AXIAL AND
(DRY) ROTARY SCREW COMPRESSORS IN CRITICAL SERVICE**

SYSTEM	EQUIPMENT	BY VENDOR		BY PURCHASER		
		FUNCTIONAL HARDWARE (QUANTITY AS INDICATED)	MOUNTING LOCATION	FUNCTIONAL HARDWARE	MOUNTING LOCATION	LOGIC
Lube Oil System	Oil Reservoir	TW & TID LG LS LS*	T T T T	— — LLA LHA*	— — LP LP	
	Oil Pump - Standby	PL(CI) & PCV Note 3 PI (Two) & PT	P P	— PHA	— LP	
	Oil Pump - Main	PI (Two)	P	—	—	
	Pump Discharge Header	PCV PI TW & TID	P P P	— — —	— — —	
	Oil Coolers - Oil Outlet	TW & (TC) TW & TID TCV	P P P	TLA, THA, TI — —	LP Note 1 — —	
	Oil Filter	PdI PdT Note 2	P P	— PdHA	— LP	
	Accumulator, Direct Contact Type	PI (Charge Gas) LG LT LT LLCV	P T T T P	— — LHA LLA —	— — LP LP —	
	Oil Supply Header	PI PT (Three)	P P	— PLA PLL(CI), PLL(CI)A	— LP Note 3	TMR 2-0-0-3
	Lube Oil Header	PCV, PI PT (Three)	P P	— PI PLA PLL(CO) & PLL(CO)A	— LP LP Note 4 LP	TMR (2-0-0-3)
	Compressor Drains, Each Bearing	FI (Sight Glass) TW & TID	P P	— —	— —	
	Coupling Housing Drain	FI (Sight Glass)	P	—	—	
Control Oil System	Control Oil Header	PCV (If Applicable) PI PT	P P P	— PI PLA	— LP LP	
Seal Oil System	Oil Reservoir	TW & TID LG LS	T T T	— — LLA	— — LP	
	Oil Pump - Standby	PI & PT	P	PHA	LP	
	Oil Pump - Main	PI	P	—	—	
	Oil Coolers - Oil Outlet	TW & (TC) TW & TID TCV	P P P	TI, THA — —	LP Note 16 — —	