



## Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)



### Instrument & Control/Safety System Design Criteria

Contract No.:  
053-073-9189

Project	Package	Contractor	Fac.	Disc.	Doc. Type	Ser. No.	Rev.
BH	17	SM	100	IN	DC	0052	D02

Page 1 of 55

# Instrument & Control/Safety System Design Criteria

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- IFC: Issued For Comment
- IFA: Issued For Approval
- IFR: Issued for Review
- AFD: Approved For Design
- AFC: Approved For Construction
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Project	Package	Contractor	Fac.	Disc.	Doc. Type	Ser. No.	Rev.
BH	17	SM	100	IN	DC	0052	D02

Page 2 of 55





### Tabulation of Revised Pages

Page	Revision						Revision description	Page	Revision					Revision description
	Rev. D00	Rev. D01	Rev. D02	Rev. D03	Rev. D04	Rev. D05			Rev. D00	Rev. D01	Rev. D02	Rev. D03	Rev. D04	
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2	x	x	x					52			x			
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5	x	x						55			x			
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 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 3 of 55

## Table of Contents





<b>1. INTRODUCTION.....</b>	<b>7</b>
<b>2. SCOPE .....</b>	<b>7</b>
<b>3. DEFINITIONS .....</b>	<b>8</b>
<b>4. CODES AND STANDARDS.....</b>	<b>8</b>
<b>5. REFERENCE DOCUMENTS.....</b>	<b>11</b>
<b>6. ABBREVIATIONS .....</b>	<b>12</b>
<b>7. ENVIRONMENTAL CONDITIONS .....</b>	<b>14</b>
7.1. Site Condition.....	14
7.2. Tropicalization .....	14
7.3. Ingress Protection .....	14
<b>8. CONFLICTS AND DEVIATIONS .....</b>	<b>14</b>
<b>9. BASIC PRINCIPLES .....</b>	<b>15</b>
9.1. Units of Measurement .....	15
<b>10. INSTRUMENT SYMBOLS.....</b>	<b>15</b>
<b>11. GENERAL INSTRUMENT REQUIREMENT .....</b>	<b>15</b>
11.1. Electrical Power Supply .....	15
11.2. Instrument Air System.....	16
11.3. Electrical Hazardous Classification .....	17
11.4. Signal Transmission .....	17
11.5. Safety Instrument .....	17
11.6. Marking and Tagging.....	17
11.7. Measuring Range of Instruments.....	18
11.7.1. Differential Pressure Flow Meters .....	18
11.7.2. Variable Area Flow Meters .....	18
11.7.3. Displacement Type Level Instruments .....	18
11.7.4. Pressure Instruments .....	19
11.7.5. Local Temperature Instruments .....	19
<b>12. Flow Instruments .....</b>	<b>19</b>
12.1. Primary Elements .....	19
12.1.1. Orifice Plates .....	19
12.2. Variable Area Flow Meters .....	20
12.2.1. Construction.....	
<b>13. Level Instruments .....</b>	

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 4 of 55

<b>13.1. General .....</b>	<b>21</b>
13.1.1. Local Indication .....	21
13.1.2. Continuous Measurement .....	21
13.1.3. Point Level Detection.....	21
<b>13.2. Magnetic-Type Gauges.....</b>	<b>21</b>
13.2.1. General Application .....	21
13.2.2. Materials.....	21
13.2.3. Connections .....	22
13.2.4. Gauge Cock Valves.....	22
13.2.5. Vent and Drain Connections .....	22
<b>13.3. Displacer Type Level Instrument.....</b>	<b>22</b>
13.3.1. Electronic Transmitter.....	23
13.3.2. Displacer and Cages .....	23
13.3.3. Connections .....	23
<b>13.4. DP LEVEL INSTRUMENT .....</b>	<b>23</b>
<b>14. PRESSURE INSTRUMENTS .....</b>	<b>24</b>
14.1. Pressure Gauges.....	24
14.1.1. Accuracy for the Pressure Gauges .....	25
14.1.2. Range Selection.....	25
14.1.3. Diaphragm Seal Gauges.....	26
14.2. Pressure Transmitter .....	26
14.3. Pressure Switches .....	27
14.4. Diaphragm Seal Systems.....	27
<b>15. TEMPERATURE INSTRUMENTS .....</b>	<b>28</b>
15.1. Thermometers.....	28
15.1.1. BI-Metal.....	28
15.1.2. Over Temperature Protection .....	28
15.1.3. Accuracy .....	28
15.1.4. Standard Ranges.....	29
15.1.5. Connection.....	29
15.1.6. Material .....	29
15.1.7. Liquid Filled System Thermometers .....	29
15.2. Temperature Sensing .....	29
15.2.1 Resistance Temperature Detector (RTD).....	30
15.2.2 Thermocouple .....	
15.3. Thermowells.....	





 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 5 of 55

<b>15.4. Transmitters.....</b>	<b>31</b>
<b>15.5. Measuring Systems .....</b>	<b>31</b>
<b>15.6. Temperature Switches.....</b>	<b>31</b>
<b>15.7. Filled System .....</b>	<b>33</b>
<b>16. CONTROL VALVE .....</b>	<b>34</b>
<b>17. ON/OFF VALVE.....</b>	<b>35</b>
<b>18. SELF-ACTUATED PRESSURE REGULATOR .....</b>	<b>36</b>
<b>19. VALVES ACCESSORIES .....</b>	<b>36</b>
<b>20. PRESSURE SAFETY VALVES.....</b>	<b>37</b>
<b>21. CORROSION COUPON/PROBE/TRANSMITTER.....</b>	<b>37</b>
<b>22. ANALYZERS .....</b>	<b>38</b>
<b>23. I/P CONVERTER.....</b>	<b>38</b>
<b>24. RESTRICTION ORIFICE .....</b>	<b>39</b>
<b>25. INSTRUMENTS INSTALLATION PHILOSOPHY .....</b>	<b>39</b>
<b>25.1. Instrument Cabling and Wiring.....</b>	<b>40</b>
<b>25.1.1 Underground Cable Installation .....</b>	<b>40</b>
<b>25.1.2 Above Ground Cable Installation .....</b>	<b>41</b>
<b>26. CONTROL AND MONITORING SYSTEM.....</b>	<b>41</b>
<b>26.1. Programmable Logic Controller (PLC) .....</b>	<b>41</b>
<b>26.2. Emergency Shutdown (ESD) System.....</b>	<b>42</b>
<b>26.3. Fire and Gas Detection Systems .....</b>	<b>43</b>
<b>26.4. Interposing Relay Panels (IRPs) .....</b>	<b>44</b>
<b>27. INSTRUMENT REQUIREMENTS INSTALLED IN THE CONTROL BUILDINGS .....</b>	<b>45</b>
<b>27.1. Auxiliary Cabinets.....</b>	<b>45</b>
<b>28. INSTRUMENT CABLES .....</b>	<b>46</b>
<b>29. JUNCTION BOXES .....</b>	<b>47</b>
<b>30. INSTRUMENT EARTHING.....</b>	<b>47</b>
<b>31. INSTRUMENT INSPECTION AND TESTING PHILOSOPHY .....</b>	<b>48</b>
<b>31.1. General .....</b>	<b>48</b>
<b>31.2. Flushing of Lines.....</b>	<b>49</b>
<b>31.3. Instrument Supply Lines .....</b>	<b>49</b>
<b>31.4. Instrument Signal Lines.....</b>	<b>49</b>
<b>31.5. Impulse Lines .....</b>	<b>49</b>
<b>31.6. Direct Mounted Instruments .....</b>	
<b>31.7. Wiring.....</b>	

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 6 of 55

<b>31.8. Calibration &amp; Testing .....</b>	<b>50</b>
<b>31.9. Testing and Calibration Report .....</b>	<b>50</b>
<b>32. INSTRUMENT SPARE PHILOSOPHY .....</b>	<b>51</b>
<b>33. PACKING AND SHIPMENT .....</b>	<b>51</b>
<b>34. DOCUMENTATION .....</b>	<b>52</b>
<b>34.1. Equipment Documentation .....</b>	<b>52</b>
<b>34.2. Instrument Index .....</b>	<b>54</b>
<b>34.3. Instrument Data Sheet .....</b>	<b>54</b>
<b>34.4. Instrument Calculations .....</b>	<b>55</b>

  
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 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 7 of 55

## 1. INTRODUCTION

National Iranian South Oil Company (NISOC) plans to conduct an integrated project includes several sub-projects to preserve and increase production of Gachsaran oil fields located in south of Iran Khuzestan and Bushehr provinces as follow:





- 1) Revamping of Production and Desalting Units of Bibi Hakimeh 1&2
- 2) Fabrication & Installation a Preheater, Stripping Column and Related Equipment for Nargesi Production Unit

The purposes of first sub-project are equipping and extension of Bibihakime-2 desalting unit to achieve 110,000 SBPD desalted crude oil, and necessary modifications in Bibihakime-2 desalting & production units and Bibihakime-1 production unit so that the new plants will be able to process crude oil with 22% water cut and transfer waste water from Bibihakime-1 production unit to waste water treatment facilities in Bibihakime-1 desalting unit via installation of a none-metal pipe. Therefore, National Iranian South Oil Company (NISOC) has announced this project.

The purpose of second sub-project is crude oil sweetening in Nargesi plant by new design and necessary modifications in existing facilities. National Iranian South Oil Company (NISOC), on behalf of the National Iranian Oil Company (NIOC) is responsible to exploit oil and gas from onshore fields in the south district of Iran. According to management of planning & international affairs of National Iranian Oil Company (NIOC) pronouncement, H<sub>2</sub>S content and RVP specification of exported oil shall be in the specified allowable range; Accordingly, NISOC has decided to fulfil a project, investigating and probing required equipment and operational conditions to meet the desired crude oil specifications of sulphur content and RVP for Nargesi production units.

## 2. SCOPE

This specification defines general design criteria for instrumentation and control systems of “Revamping of Production and Desalting Units of Bibi Hakimeh 1&2” and “Fabrication & Installation a Preheater, Stripping Column and Related Equipment for Nargesi Production Unit” sub-projects.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 8 of 55

The purpose of instrumentation is to provide a system such that all the required information / data / signal in the desired form and place are available and they work for safe monitoring, controlling and operation of the process and associated systems and to make the required information available at control centres in required form.

The designer/specifier may use this document in the design, procurement, and implementation of all or a portion of a system. The designer/specifier shall select those portions of this document that are applicable to a specific system. This may include the modification of tables and requirements contained herein.

### 3. DEFINITIONS

Within the context of this document, the following definitions are applicable

Owner/Client	: National Iranian south oil company (NISOC)
Title	: Development Plan of 28 Reservoirs/ BIBI HAKIMEH Oilfield (EPC)
Contractor	: Mashin Sazi Arak/ Sealand Engineering and Well Services JV
Consultant	: <b>Tehran Raymand Consulting Engineers</b>
Will:	Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.
May:	Is used where a provision is completely discretionary
Should:	Is used where a provision is advisory only.
Shall:	Is used where a provision is mandatory.

### 4. CODES AND STANDARDS






The codes and standards which are listed below shall be followed as applicable:

#### ➤ Process Piping

ANSI-B16.5	Pipe flanges and flanged fittings
ANSI-B16.36	Orifice flanges
IPS-M-PI-150(2)	Material Standard for Flanges and Fittings

#### ➤ Instrument Symbols

ANSI/ISA-5.1	Instrumentation Symbols and Identification
ANSI/ISA-5.2	Binary Logic Diagrams for Process Operations

 NISOC	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								 MACHINE SAZI ARAK  SeaLand  TR 
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 9 of 55

ISA-5.3

Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems

ANSI/ISA-5.4

Instrument Loop Diagrams

ISA-5.5-1985

Graphic Symbols for Process Displays

➤ **Instrument Air**

IPS-G-IN-200(1)

General Standard for Instruments air system

ISA-7.0.01

Quality Standard for Instrument Air

➤ **Temperature Measurement**

IPS-C-IN-120(1)

Construction Standard for Temperature Instruments

IPS-E-IN-120(1)

Engineering Standard for Temperature Instruments

IPS-M-IN-120(1)

Material and Equipment Standard for Temperature Instruments

API-MPMS-Chapter7

Temperature determination

IEC-60751

Industrial platinum resistance thermometer sensors

BS-1041-4

Temperature measurement

BSI-2765

Specification for Dimensions of Temperature

Detecting Elements and Corresponding Pockets

➤ **Flow measurement**

IPS-C-IN-130(2)

Construction Standard for Flow Instruments

IPS-E-IN-130(1)

Engineering Standard for Flow Instruments

IPS-M-IN-130(1)

Material and Equipment Standard for Flow Instruments

API-MPMS 14.3.1

Orifice Metering of Natural Gas and Other Related Hydrocarbon

Fluids—Concentric Square-Edged Orifice Meters, Part 1: General

Equations and Uncertainty Guidelines

API-MPMS 21.1

Flow Measurement Using Electronic Metering systems

ISO-5167-1

Measurement of fluid flow by means of pressure differential devices

ISO 5168

Measurement of fluid flow – Evaluation of Uncertainties

➤ **Level measurement**

IPS-C-IN-140(2)

Construction Standard for Level Instruments

IPS-E-IN-140(1)

Engineering Standard for Level Instruments

IPS-M-IN-140(1)

Material and Equipment Standard for Level Instruments

➤ **Pressure measurement**

IPS-C-IN-110(1)





Construction Standard for Pressure Instruments

IPS-E-IN-110(1)

Engineering Standard for Pressure Instruments

IPS-M-IN-110(1)

Material and Equipment Standard for Pressure Instruments

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 10 of 55

➤ **Valves**

IPS-C-IN-160	Construction And Installation Standard For Control Valves
IPS-E-IN-160	Engineering Standard For Control Valves
IPS-M-IN-160	Material Standard For Control Valves

➤ **General Instrumentation / Control System**

IPS-C-IN-100(1)	Construction and Installation Standard for General Instruments Field Inspection, Calibration & Testing of Instrument and Instrument System
IPS-E-IN-100(1)	Engineering Standard for General Instrumentation
IPS-I-IN-100(1)	Inspection Standard for General Instrument systems
IPS-G-IN-220(1)	Engineering and Installation Standard for Control Center
IPS-G-IN-260(1)	Engineering and Installation Standard for Indicating Lights, Alarms & Protective Systems
IPS-G-IN-290(1)	Engineering and Construction Standard for Programmable Logic Controllers (PLC)
API-RP 551	Process measurement Instrumentation
API-RP 554	Process Control Systems
ISA- RP 60.6	name plates, label and tags for control centers
ISA-RP60.8	Electrical Guide for Control Centers
ISA-71.01	Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity
ANSI/ISA-18.1	Annunciator sequences and Specifications
ANSI/ISA-84.00.01	Functional Safety: Safety Instrumented Systems for the Process Industry Sector
ISA-TR20.00.01	Specification Forms for Process Measurement and Control Instruments

➤ **Corrosion Protection**





NACE-MR0175	Sulfide stress cracking resistant metallic materials for oil field equipment
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➤ **Transmission System**

IPS-C-IN-190(1)	Installation and Construction Standard for Transmission Systems
IPS-E-IN-190(2)	Engineering Standard for Transmission Systems
IPS-M-IN-190(2)	Material and Equipment Standard for Transmission Systems
API-RP 552	Transmission Systems

➤ **Instrument Cable**

BS EN 50288-7	Multi-element metallic cables used in analogue and digital communication and control
BS 6121-1	Mechanical cable glands. Armour glands. Requirements and test methods
UL-4	Standard for Armored Cable
NEMA WC 26	Bi-national Wire and Cable Packaging Standard

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 11 of 55

NEMA WC 57 Standard For Control, Thermocouple Extension, And Instrumentation Cables

IEC-60332-1-2 Test on electric and optical fiber cables under fire conditions

IEC-60228 Conductors of insulated cables

IEC-60811-100 Electric and optical fiber cables - Test methods for non-metallic materials

#### ➤ Electrical

ISA 12.00.01 Explosive Atmospheres - Part 0: Equipment - General Requirements

ISA 12.01.01 Definitions and Information Pertaining to Electrical Equipment in Hazardous (Classified) Locations

ISA 12.02.01 Explosive Atmospheres - Part 11: Equipment protection by intrinsic safety "i"

ISA 12.12.01 Non incentive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations

ISA 12.16.01 Explosive Atmospheres - Part 7: Equipment Protection by Increased Safety "E"

ISA 12.22.01 Explosive Atmospheres - Part 1: Equipment Protection by Flameproof Enclosures "d"

ISA RP12.2.02 Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings

ISA 12.04.04 Pressurized Enclosures

ISA RP12.06.01 Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety

ISA TR12.2 Intrinsically Safe System Assessment Using the Entity Concept

ISA TR12.12.04 Electrical Equipment in a Class I, Division 2/Zone 2 Hazardous Location

ISA TR12.24.01 Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

IEC-60079-0 Explosive atmospheres - Part 0: Equipment - General requirements





ANSI/IEC 60529 Degree of protection provided by enclosure (IP Code)

## 5. REFERENCE DOCUMENTS

Process Design Basis for Bibi Hakimeh Production Unit No.1\_BH-17-SM-100-PR-DB-0158

Process Design Basis for Bibi Hakimeh No.2\_BH-17-SM-100-PR-DB-0564

Process Design Basis for Nargesi\_BH-18-SM-100-PR-DB-0002





 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 12 of 55

## 6. ABBREVIATIONS





The following abbreviations are commonly used in this document:

AI	Analog Input
AO	Analog Output
ANSI	American National Standard institute
API	American Petroleum institute
ASTM	American Society for Testing and Material
ATEX	Atmosphere Explosible
AWG	American Wire Gauge
BMS	Burner Management System
BS	British Standards
CENELEC	European Committee for Electrical Standardization
CPU	Central processing Units
CCR	Central Control Room
dBA	Decibel Absolute
DC	Direct Current
DCS	Distribute Control System
DI	Digital Input
DO	Digital Output
DPDT	Double Pole Double Throw
EEX	Europe Explosion Proof
EMC	Electromagnetic compatibility
EMI	Electromagnetic Interference
ESD	Emergency Shut Down
EWS	Engineering Work Station
FAT	Factory Acceptance Test
FGS	Fire and Gas System
F.S	Full Scale

  
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	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 13 of 55

HMI	Human Machine Interface
I&C	Instrumentation and Control
IEC	International Electrotechnical Commission
I/O	Input/output
IP	Ingress Protection
IPC	Industrial Personal Computer
IPS	Iranian Petroleum Standard
I.S.	Intrinsically Safe
ISA	International Society of Automation
ISO	International Standard Organization
JB	Junction Box
MCC	Motor Control Center
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair
NACE	National Association of Corrosion Engineering
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NPT	National Pipe Thread
OWS	Operator Work Station
OD	Outside Diameter
LED	Light Emitting Diode
P&ID	Piping and Instrumentation Drawing
PCS	Process Control System
PLC	Programming Logic Controller
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detector
SI	System International of Units
SPDT	Single Pole Double Throw
UCP	Unit Control Panel

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 14 of 55

UPS Uninterruptible Power Supply

UV Ultra Violet

## 7. ENVIRONMENTAL CONDITIONS

### 7.1. Site Condition

All the environmental data used in this document and is expected to be considered, shall be obtained from “Process Design Basis for Bibi Hakimeh Production Unit No.1\_BH-17-SM-100-PR-DB-0158”, “Process Design Basis for Bibi Hakimeh No.2\_BH-17-SM-100-PR-DB-0564” and “Process Design Basis for Nargesi\_BH-18-SM-100-PR-DB-0002”.

### 7.2. Tropicalization

The instruments shall be tropicalized to eliminate mildew, fungi and other detrimental effects of a tropical environment and dust, if needed. Electronic circuit boards shall be suitably protected against corrosion and humidity by applying a protective coating, where deemed necessary. Packaging shall be suitable for shipment and storage under tropical conditions.





### 7.3. Ingress Protection

All field mounted equipment shall be suitable for the environmental conditions. Particular attention shall be paid to possible effects of corrosion, vibration, humidity, and extremes of temperatures.

## 8. CONFLICTS AND DEVIATIONS

Any conflicts between this specification and other applicable specifications, engineering standards, industry standards, codes, etc., shall be resolved in writing by the Owner or Owner's Representative.

  
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 شماره ثبت: ۴۱۴۵۵۰

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project	Package	Contractor	Fac.	Disc.	Doc. Type	Ser. No.	Rev.	Page 15 of 55
	BH	17	SM	100	IN	DC	0052	D02	

## 9. BASIC PRINCIPLES

### 9.1. Units of Measurement

Generally, International System of units (SI) shall be used. All dimensions and ratings shall be metric. Except for the temperature, which shall be in degrees Celsius instead of Kelvin, and for pipes and fittings threads, which shall be in inches of NPT.

Variable		Units
Temperature		Celsius degree (°C)
Pressure Relative		Psig or Barg
Pressure Absolute		PsiA or barA
Level		m or mm, % of range
Flow	Liquid	kg/h or m <sup>3</sup> /h
	Gas or vapor	m <sup>3</sup> /h or Sm <sup>3</sup> /h(l) or kg/h
	Air or nitrogen	m <sup>3</sup> /h or Sm <sup>3</sup> /h(l) or kg/h
Analysers		pH, molar%, ppm % LEL
Density Liquid Gas		Kg/m <sup>3</sup> kg/m <sup>3</sup> .Or.kg/Sm <sup>3</sup> (l)

## 10. INSTRUMENT SYMBOLS

Instrumentation symbols and identifications of functions shall be according to latest edition of ISA S5-1, S5-2 and S5-3 standard

## 11. GENERAL INSTRUMENT REQUIREMENT





### 11.1. Electrical Power Supply

110 VAC, 50Hz uninterrupted power shall be used for the supply of control systems, local panels, Printers, monitors, PC-s etc.

Control system power supply shall be in accordance with IPS-M-IN-290. The system power supply shall be provided to operate the PLC's processor. The power supply shall be in redundant hot stand-by configuration to provide power directly to the system chassis backplane.

Electric supply (UPS Supported):	110 V AC, 50 Hz
Electric supply (Non-UPS Supported):	230 V AC, 50 Hz
Electric measurement signal:	4 to 20 mA (DC)

  
 ATRIN RAD MEHR  
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 شماره ثبت: ۴۱۴۵۵۰

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 16 of 55

Instrument Discrete input:	Supervisory and system control voltage
Electrical interface discrete input:	24 V DC
Solenoid control signal:	24 V DC
Electrical interface discrete output:	24 V DC
Relays:	24 V DC

## 11.2. Instrument Air System

All the pneumatic components of instrument system shall be designed for the instrument air supply conditions as are stated in the documents “Process Design Basis for Bibi Hakimeh Production Unit No.1\_BH-17-SM-100-PR-DB-0158”, “Process Design Basis for Bibi Hakimeh No.2\_BH-17-SM-100-PR-DB-0564” and “Process Design Basis for Nargesi\_BH-18-SM-100-PR-DB-0002”.

- Instrument air specification of Bibi Hakimeh Production Unit No.1





Specification	Value
Dew Point @ 100 psig (°C)	- 14
Supply Temperature (°C)	Max. 50
Normal Supply Pressure (min/max) (barg)	2.7-4

- Instrument air specification of Bibi Hakimeh Production and Desalting Unit No.2

Specification	Value
Dew Point @ 100 psig (°C)	- 14
Supply Temperature (°C)	Max. 50
Normal Supply Pressure (min/max) (barg)	2.7-4

- Instrument air specification of Nargesi production unit

Specification	Value
Maximum Supply Pressure (barg)	10
Normal Supply Pressure (barg)	8
Minimum Supply Pressure (barg)	4
Design Pressure (barg)	10
Supply Temperature (°C)	60

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 17 of 55

Design Temperature (°C)	95
Minimum Temperature (°C)	-6
Dew Point	-40 °C @ 8 Barg
Quality	Dust free-Oil free

### 11.3. Electrical Hazardous Classification

All electrical devices, electronic instrumentation and wiring installation shall be suitable for installation in the relevant electrical area classification.

### 11.4. Signal Transmission

Analog signal shall be 4-20mA HART, mV, Thermocouple, and RTD.

Digital signal shall be 24VDC.

### 11.5. Safety Instrument

Field switch and field panel mounted switches (including ESD push buttons) shall have hermetically sealed contacts.

All alarms and shutdown switches shall be fail-safe design:

- Switch contacts for alarms and shutdowns shall be normally close, and shall be opened at incident.
- Status switch contacts shall be normally open and closed to indicate its status.





### 11.6. Marking and Tagging

As a minimum, the following marking of general items shall be placed on the nameplate of all instruments.

- Manufacturer's name
- Model number
- Serial number

The relevant items of the following general specification shall be marked on the nameplate of all instruments.

- Tag number
- Material of body and trim
- Connection size and rating

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 18 of 55

All Instruments, Local panels, auxiliary racks, cabinets, junction boxes and cables shall be provided with a nameplate, showing the identification number.

## 11.7. Measuring Range of Instruments

### 11.7.1. Differential Pressure Flow Meters

Measuring ranges shall be selected from the following standard ranges:

0 – 10 x 10 M	0 – 40 x 10 M
0 – 12 x 10 M *	0 – 45 x 10 M *
0 – 15 x 10 M	0 – 50 x 10 M
0 – 18 x 10 M *	0 – 55 x 10 M *
0 – 20 x 10 M	0 – 60 x 10 M
0 – 25 x 10 M	0 – 70 x 10 M
0 – 30 x 10 M	0 – 80 x 10 M
0 – 35 x 10 M *	0 – 90 x 10 M *

Notes: M means exponents and will be integer. Measuring ranges marked with asterisk (\*) shall preferably not be used. The measuring ranges which are not shown will be adopted where required.

### 11.7.2. Variable Area Flow Meters

Measuring ranges shall be selected from the following standard ranges.





10 x 10 M	4.0 - 40 x 10 M
12 x 10 M	4.5 - 45 x 10 M
1.5 - 15 x 10 M	5.0 - 50 x 10 M
1.8 - 18 x 10 M	5.5 - 55 x 10 M
2.0 - 20 x 10 M	6.0 - 60 x 10 M
2.5 - 25 x 10 M	7.0 - 70 x 10 M
3.0 - 30 x 10 M	8.0 - 80 x 10 M
3.5 - 35 x 10 M	9.0 - 90 x 10 M

### 11.7.3. Displacement Type Level Instruments

Measuring ranges shall be follows:

356mm	813mm	1219mm	1524mm	1829mm	2134mm	2438mm	2734mm	3048mm
14"	32"	48"	60"	72"	84"	96"	108"	120"

Note: For ranges above 1219mm (48 in.) a differential pressure instrument shall be considered

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 19 of 55

#### 11.7.4. Pressure Instruments

Measuring ranges and units shall be as follows:

a) Pressure

0-1, 0-1.6, 0-2.5, 0-4, 0-6, 0-10, 0-16, 0-25, 0-40, 0-60, 0-100, 0-160, 0-250, 0-400, 0-600, 0-1000 barg

b) Vacuum

-1~0 barg

c) Compound

-76mmHg to 0 to +1.5 barg

-76mmHg to 0 to +3.0 barg

-76mmHg to 0 to +5.0 barg

-76mmHg to 0 to +9.0 barg

Note: The measuring ranges which are not shown will be adopted where required.

#### 11.7.5. Local Temperature Instruments

Local temperature instruments shall have one of the following measuring ranges:

Measuring range (deg C):

-30 – 70/ 0 – 250/ 0 – 100/ 0 – 400 /0 – 120/ 50 – 650/ 0 – 160

## 12. FLOW INSTRUMENTS

Differential pressure transmitter in conjunction with orifice plate shall be used as first choice for all flow measuring applications.

The flow instrument shall be designed in accordance with API-MPMS CH-14-3-2, IPS-E-IN-130, IPS-M-IN-130 and IPS-C-IN-130 recommendations.





This section covers the minimum design criteria for primary flow elements and transmitters.

### 12.1. Primary Elements

#### 12.1.1. Orifice Plates

The standard range for differential pressure meters shall be: 500 mm, 1250 mm, 2500 mm and 5000 mm water gauge.

Primary elements shall be sized for used with differential transmitters having one of the following

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 20 of 55

ranges in mbar:

0-12.5, 0-25, 0-50, 0-75, 0-100, 0-125, 0-250, 0-500, 0-1000

Differential pressure range shall normally be 0.25 bar (100" water column).

Meter range shall be selected in accordance with the following guide lines. For orifice meters, normal flow rate shall be between 70% and 80% of capacity provided; anticipated minimum, maximum flow rate shall be between 30% and 95% of capacity.

Orifice plates shall generally be for flow measurement; except in the following circumstances:

- Where accuracy required is higher than normally obtained from an orifice plate
- Where wide vibrations in flow rate occur
- Where system allowable pressure drop is very small

The pipe size shall be expanded in diameter to avoid d/D ratios exceeding 0.75.

Orifice meter differential range and pipe size shall be selected so that the ratio of orifice diameter to actual internal pipe diameter (d/D) be between 0.2 –0.75.

For gas service, a Cp/Cv ratio of 1.3 may be used in the calculation of the orifice bore.

Orifice flange shall be in accordance with ANSI/ASME B16.36.

The minimum orifice flange rating shall be 300 lbs ANSI.

Plate material shall be 316 or equivalent stainless steel or such material as demanded by process conditions.

## 12.2. Variable Area Flow Meters

Variable area flow meters may be used for small flow rates where local indication, recording and/or controlling is required. They may also be used where rangeability, nonlinearity, viscosity or the hazardous nature of fluid makes the differential pressure type instrument unsuitable.

Variable area flow meters shall be of metal tube type in principle.

Variable area flow meters shall be installed so that repair, maintenance and replacement will not disturb the operation of the plant.

### 12.2.1. Construction





Area flow meters of 3/4" or larger shall have flanged connections.

Metal tube type meters shall have magnet coupling mechanism for float position detection.

Process connections of meters shall be bottom-side or bottom-top.

Bodies shall have the same pressure rating as that of process line.

Metering tubes and floats of metal tube type meters shall be of 316 stainless steel.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 21 of 55

### 13. LEVEL INSTRUMENTS

Level measurement shall be designed in accordance with IPS-E-IN-140, IPS-C-IN-140 and IPS-M-IN-140 recommendations.

#### 13.1. General

##### 13.1.1. Local Indication

The following local level instrument types shall be used:

- Magnetic-Type gauges for vessels and small tanks.
- Float type instruments for large tanks, where local indication only is necessary or differential pressure instruments where float type instruments are not suitable.

##### 13.1.2. Continuous Measurement

Displacer type instruments may be used for interface measurement where the range does not exceed 1219mm. The standard ranges of 356, 813 and 1219mm shall be used.

Differential pressure instruments may be used as first choice for all level applications.

Other types of measurement, e.g. capacitance and ultrasonic may be used where differential pressure instruments or displacers are unsuitable.

##### 13.1.3. Point Level Detection

External chamber 'Ball float' operated instruments shall be used for point level detection.

For shutdown service, level switch shall be used.

#### 13.2. Magnetic-Type Gauges





##### 13.2.1. General Application

Each gauge shall be stamped with the maximum working pressure and temperature which is equal to or higher than the vessel design pressure and temperature ratings.

Magnetic type level gauges shall be applied for all services instead of gauge glasses

##### 13.2.2. Materials

The materials to be used for valves, the fittings, and the components of Magnetic-Type gauges in contact with process fluids shall be equal to or higher than the materials specified on individual data sheets and the piping specification.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 22 of 55

### 13.2.3. Connections

Vent and drain connections shall be 3/4" NPT female or flanged as per the vessel trim. Seal welding shall not be provided on these connections.

Vessel connections shall normally be 2" flanged with ASME 300 lbs minimum rating unless otherwise stated due to vessel rating.

### 13.2.4. Gauge Cock Valves

Where Magnetic-Type gauges are installed in steam condensate, non-corrosive liquids or light hydrocarbon services, they shall be provided with gauge cock valves to set off flow in the event of the gauge glass failure or rupture.

Gauge cock valves for end connected Magnetic-Type gauges shall be offset type forged carbon steel, with horizontal ball checks, 2" flanged vessel connections, 3/4" NPT (F) threaded vent and drain connections and 3/4" NPT threaded Magnetic-Type gauge connections.

Gauge cock valves for side connected or closed coupled Magnetic-Type gauges shall be flat type forged carbon steel, with horizontal ball checks, 2" flanged tank connections and 3/4" NPT threaded Magnetic-Type gauges connections. Side connected Magnetic-Type gauges shall have 3/4" NPT female vent and drain connections.

Gauge cock valves shall be quick closing and lever operated.

### 13.2.5. Vent and Drain Connections





All gauges shall be supplied with a shut-off valve on the top and bottom mountings and a full bore drain valve. Shut-off valves shall be of a quick acting, offset type and shall have bolted bonnets. A vent valve shall be provided on toxic services or on corrosive liquid and liquid interface duties to allow for piping for safe fluid disposal. A vent plug shall be provided where a vent valve is not fitted.

## 13.3. Displacer Type Level Instrument

Displacers in externally mounted chambers shall be used for general control and general services when one of the following conditions is present:

- The process level is less than 2400 mm
- Volume is critical

  
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 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 23 of 55

#### 13.3.1. Electronic Transmitter

Displacer transmitters shall be electronic type 4-20mA HART transmitter. They shall be installed in the instrument cases associated with the displacer cages.

Maximum error shall not be greater than 0.5% of span. Hysteresis shall not be greater than 0.2% of span. A means of correcting for specific gravity shall be provided.

#### 13.3.2. Displacer and Cages

Chambers shall be designed with side-and-side connections with rotate-able heads wherever possible.

Displacement level instruments shall be provided with flanged connections.

The bottom of the cages with a side bottom connection (a side nozzle for lower connection) shall be drilled and tapped 3/4" NPT (F) for drain piping.

Also, the top of the cages with a side top nozzle shall be drilled and tapped 3/4" NPT for vent connection.

When ring joint flanged equalizing connections are specified, the float cage body, flanges, head flanges, and torque tube and arm flanges must be of ring joint construction or have retaining gaskets.

Displacer type instruments shall normally be carbon steel bodied with stainless steel displacer.

#### 13.3.3. Connections





All the flanged connections shall be 2" in accordance with ANSI B16.5 and shall have a minimum, 300 lbs rating. The type of connection and flange rating for each displacer shall be stated on the individual data sheets.

### 13.4. DP Level Instrument

The level transmitters shall be electronic type with 4-20 mA HART output, with full Elevation and suppression availability to have the increasing/decreasing output signals according to the increasing on the liquid levels or the interface levels.

Flange mounted transmitters; flush or extended type may be specified. Also, liquid filled systems, chemical seals and capillary tubing shall be considered for use where necessary. In these cases, the size of the flange shall be 3" ANSI 300 lbs as a minimum.

All internals in contact with the process shall be 316 SS unless otherwise specified.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 24 of 55

Accuracy of all measuring devices shall be at least 0.5% of full span.

DP cells shall generally be used for clean liquids in atmospheric and pressurized tanks, hard to handle liquids in atmospheric and pressurized tanks, and for interface detection.

## 14. PRESSURE INSTRUMENTS

### 14.1. Pressure Gauges

The bourdon tube pressure gauge shall be designed in accordance with IPS-E-IN-110, IPS-M-IN-110 and IPS-C-IN-110 recommendation.

Dials shall have diameter of 150 mm and shall be white with black figures, non-rusting metal or plastic.

Blow out disc shall be located in the back of the casing.

Pressure elements shall be bellows or bourdon as specified in data sheets.

Unless otherwise specified, 316 stainless steel shall be used for pressure elements, sockets and tips material.

Gauge cases shall be either:

- Cast aluminum with weather proof screw ring type.
- Natural finished 316 stainless steel with bayonet type bezel ring and neoprene gasket
- Special plastic such as black phenol (UV resistant)
- Blowout plug reinforced poly-butylenes plastic window

Direct and surface mounted gauges shall have 1/2" NPT male bottom connection with wrench flats.

Flush mounted direct connected gauges shall have 1/2" NPT male back connection with wrench flats.

Surface mounted gauges shall have rubber blow out disc located in the lower side of case. Direct and flush mounted gauges shall have rubber blow out disc located in the back of the case.





All gauges shall be equipped with screw driver slot type adjustment for calibration purposes.

Weep holes shall be provided on the case of all gauges.

Gauges for the measurement of differential pressure shall be of the bellows or diaphragm type.

Dual element gauges shall only be used when the differential pressure exceeds 10% of the available static pressure.

Bourdon tubes shall be welded to socket and tip and stress relieved as required. Materials of all wetted parts shall be 316 stainless steel types unless otherwise specified. Brass or other mate

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 25 of 55

can be used for receiver gauges.

Movement for all gauges shall be made of stainless steel to withstand vibration or pulsation.

Dials shall be white laminated steel plate with black numerals and markings.

Gauge shall be provided with shatterproof glass and a rupture hole at the back of the case. Gauges with range above 40 barg shall be safety pattern type.

The bottom section shall be removable for cleaning. The entire system above the diaphragm, including the element, shall be evacuated and entirely filled with inert liquid.

Pressure elements shall be capable of withstanding intermittent over range to 1.3 times the maximum scale reading without taking a permanent set or going off calibration.

When the pressure gauges cannot withstand the maximum pressure expected during the operation, adequate protection for overpressure (eg. gauge saver etc.) shall be provided.

All pressure gauges shall be scaled to "bar" and "psi" units.

#### 14.1.1. Accuracy for the Pressure Gauges

Guaranteed gage accuracy shall be better than  $\pm 0.6\%$  of the full scale.

#### 14.1.2. Range Selection

Ranges of pressure shall normally be in accordance with IPS-E-IN-110. For greater discrimination, narrow span instrument with elevated zero may be used.

Pressure elements measuring a steady normal operating pressure shall not exceed 75% of their maximum range. Pressure elements measuring a fluctuating pressure shall not normally be operated beyond 60% of their maximum range. Pressure range shall be specified for each gauge such that the normal operating pressure is approximately at mid-range.

For pressure gauges with ranges less than the process design pressure, over-range protection shall be provided by design or by the use of a separate over-range protector.





Instruments measuring pulsating pressures shall be fitted with pulsation dampers. The use of partially closed isolation valves is not permitted.

Scale range selection:

0-1, 0-1.6, 0-2.5, 0-4, 0-6, 0-10, 0-16, 0-25, 0-40, 0-60, 0-100, 0-160, 0-250, 0-400, 0-600, 0-1000

Barg

Suppressed ranges may be used to obtain greater accuracy through a narrow span.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 26 of 55

#### 14.1.3. Diaphragm Seal Gauges

The bottom section shall be removable for cleaning. The entire system above the diaphragm including the element shall be evacuated and entirely filled with an inert liquid.

Process connections shall be 1/2" NPT screwed bottom connections.

#### 14.2. Pressure Transmitter

Pressure range of transmitters shall be selected so that, normal operating pressure shall be within 50% and 85% of calibrated range.

Pressure instruments measuring elements may be; bourdon tube, spiral, helical, bellows or diaphragm type, depending upon the service and pressure. The measuring element shall be type 316 stainless steel, unless process fluid requires application of other materials, which in such cases, selection shall be made according to NACE MR-0175.

Instruments shall be specified to have over-range protection equal to 1.3 times of maximum pressure to which they may be exposed.

Electronic pressure transmitter may be specified as; force balance electronic, strain gage, capacitance or piezo electric type. Priority will be given to the system with better maintainability and reliability.

Pneumatic pressure transmitters shall normally be force-balance type. Motion balance type may be considered in special cases with Owner approval.

Instrument case and cover shall be made of high resistance materials.

Repeatability of the transmitter shall be better than 0.1% of the span.

The transmitter shall be supplied with a stainless-steel nameplate fastened to the casing by stainless steel screws. The following information shall be engraved on the nameplate:





- Owner's assigned tag-number
- Manufacturer's name, model and serial number
- Maximum working pressure
- Operating range limits

The transmitter mounting shall be implemented by means of DN50 (2") vertical or horizontal pipe bracket. All mounting accessories shall be provided with the instrument.

The transmitter accuracy shall be better than 0.4% of the span of instrument.

Enclosure classification shall meet IEC 529, IP 65 or NEMA type 4X

Transmitter drift shall be less than 0.1% of span over a 6 month period.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 27 of 55

Sensor fill fluid shall be silicon oil.

The electrical entrance to the transmitter shall be made by means of threaded conduit or glands.

The entrances shall be suitable for M20 gland.

The output signal of the transmitter shall be 4-20 mA. DC. HART.

Process connection of the transmitter shall be 1/2" NPT unless flange connections are specified in data sheets.

Transmitter shall be equipped with an integral indicating gage. The indicator shall read the whole span of the instrument with  $\pm 2\%$  FSD accuracy.

The electrical connection to the transmitter shall be made by means of high-quality screw terminals, suitable to accept up to 2.5 mm<sup>2</sup> wires.

The transmitter shall be equipped with suitable test jack to measure the loop current for on-line calibration.

Drainage facility shall be provided on the body of the instrument.

#### **14.3. Pressure Switches**

Pressure switches shall only be used for services specified by data sheets or for auxiliary services on packaged unit.

Pressure element shall be of diaphragms, diaphragm sealed piston or bourdon tube type.

Materials shall be 316 SS unless otherwise stated on the data sheets.

Pressure switch connection shall be 1/2" NPT male and have wrench flats.

Switches shall not be used on pressure less than 25 mbar.

The accuracy of the pressure switch assembly shall be at least  $\pm 1\%$  of calibrated span.

The set point shall be field adjustable over the full range of the switch. The set point adjustment shall be internal.





Dead band shall be less than 1% of span.

Switch element shall be micro-switch snap action type hermetically sealed. Micro-switch shall be DPDT type. Contact rating shall be 5A at 24 VDC.

Switches shall not be used with any form of over range protection device.

#### **14.4. Diaphragm Seal Systems**

Diaphragm seals shall be direct or remote type. All capillary tubing for remote type shall be corrosion resistant and sheathed or armored. Length shall be 3m and 10m (maximum). Capillary tubing shall be supported throughout its length.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 28 of 55

For general direct type applications, process connection sizes 1.5" to 3", the flanged type shall be used.

For general remote type applications, process connection sizes 1.5" to 3", the flanged type shall be used.

For smaller direct type process connection, sizes 1/2" NPT male diaphragm seals may be used.

For smaller process connection sizes 1/2" to 1", flanged remote seals may be used.

For insulated services, extended flanged seal shall be considered.

Diaphragm and wetted parts material shall be suitable for the process and shall be AISI 316 SS as a minimum.

Lower housing material shall be the same as the wetted parts, minimum AISI 316 SS.

## 15. TEMPERATURE INSTRUMENTS

Temperature instrument shall be designed in accordance with IPS-E-IN-120, IPS-C-IN-120 and IPS-M-IN-120 Recommendations.

Indicating thermometers shall be hermetically sealed, heavy-duty with stainless steel socket, straight stem or angle pattern to suit the application.

### 15.1. Thermometers

#### 15.1.1. BI-Metal

BI-metallic every angle dial thermometer shall be used for local indication. Where BI-metallic types are not suitable, gas or liquid filled capillary instruments may be used. Mercury filled systems shall not be used.

Dial size shall be 150 mm diameter.

Dial material shall be aluminium, unless otherwise specified.





Dial color shall be white, non-rusting metal with black figures.

#### 15.1.2. Over Temperature Protection

Temperature elements shall be capable of withstanding intermittent over-ranging to 1.3 times the maximum scale.

#### 15.1.3. Accuracy

Guaranteed gauge accuracy shall be 0.5% of full-scale range.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 29 of 55

#### 15.1.4. Standard Ranges

-50/50, -30/70, 0/50, 0/100, -20/120, 0/150, 0/200, 0/250, 0/300, 0/400, 50/450, 100/500.

#### 15.1.5. Connection

The thermometer stem shall be 6 mm (1/4") diameter, with 316 SS material and 1/2" NPT male connection.

#### 15.1.6. Material

Case shall be manufactured from material which gives adequate protection against environmental conditions including shocks which are likely to be encountered during transport, storage, installation, normal operation and maintenance, which is normally die-cast aluminum.

Window shall be of sheet glass having a uniform thickness of not less than 3 mm and shall be free from defects.

#### 15.1.7. Liquid Filled System Thermometers

Mercury-in-steel systems shall not be used. Where bimetallic types are not suitable, gas or liquid filled capillary instruments may be used.





All capillary tubing shall be corrosion resistant and sheathed or armored. The length of the capillary tube shall be normally 5 meters, unless otherwise specified in related data sheets. Capillary tubing shall be supported throughout its length.

### 15.2. Temperature Sensing

Thermocouples or RTDs shall be used as the means of temperature measurements for centralized control and indication and for multi-point indication or recording.

The choice between resistance thermometers and thermocouples shall take the following into consideration:

- Where accuracy of measurement is required greater than obtainable with a thermocouple, a resistance thermometer shall be used.
- Resistance thermometers shall not be used where high frequency vibration is present, e.g. in high velocity steam or gas streams.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 30 of 55

- Where narrow range duty is required i.e., less than 100°C range a resistance thermometer shall be used.

Thermocouples and resistance thermometers pocket assemblies shall be provided with weatherproof terminal heads certified for the appropriate area classification. Heads shall be orientated to prevent ingress of water.

#### 15.2.1 Resistance Temperature Detector (RTD)

Resistance elements shall be of the 3-wire type and in accordance with IPS-E-IN-120, "Engineering Standard for Temperature Instruments".

Resistance thermometers shall be connected to instruments by at least three wires normally used in 18 AWG standard copper and shall conform to DIN-43760 within the limits -22 deg C to +660 deg C.

RTD PT100 shall comply with IPS and have a resistance of 100 ohms at 0 deg C and a fundamental interval of 38 ohms. They shall be of the grade of accuracy appropriate to the application.

The use of RTDs is normally considered for applications where very narrow spans and high accuracy are required.

RTD extension wires shall be copper and color coded with polyvinyl insulation.

The use of RTDs shall normally be limited to the range of -200 oC to 750 oC.

RTDs are normally mounted in thermowell, but when very fast response times are required (5-6 seconds) they shall be designed to be used bare.

#### 15.2.2 Thermocouple





Thermocouples shall be two wire types. Thermocouple elements shall be in accordance with IPS standard.

Thermocouples shall be mineral insulated, sheathed to 6mm (1/4") diameter.

Thermocouple head terminals shall be marked with positive and negative symbols.

The signal from any thermocouple used in conjunction with a shutdown system shall not be connected to any other device.

The extension wire shall be from the same type of thermocouple.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 31 of 55

### 15.3. Thermowells

Thermowell shall be constructed in accordance with project standards from one-piece 316 stainless steel bar stock or higher-grade alloy and NACE compatible if required.

Minimum line size for thermowell installation shall be 4".

Screwed type wells shall have external thread size of 1" NPT male with 1/2" NPT female internal thread.

Flanged type wells shall be 1 1/2" Flanged Type for pipe connection and 2" Flanged Type for vessel connection with flange rating as specified on the individual data sheets with ASME 300 lbs minimum rating unless otherwise stated due to vessel rating.

Well material, nominal well length, rating and tag number shall be stamped on the side of the flange or on the hex flat for screwed type wells.

When test wells are specified, the thermowell shall be furnished with a plug of knurled head and tied with a stainless-steel chain, but without a thermometer.

### 15.4. Transmitters

Head mounted temperature transmitters shall be used for all control applications. Transmitters shall be head mounted programmable 4-20mA HART output, and shall be compatible with a variety of temperature sensors including RTDs, thermocouples and other resistance and millivolt inputs.

For RTDs, transmitters shall be mounted locally close to the head in a suitable enclosure.

The input signal shall be galvanically isolated from the output and ground.

Accuracy of the transmitter shall be 0.1% of the full scale.





### 15.5. Measuring Systems

Thermocouple and resistance thermometer circuits operating high temperature alarms shall have upscale element burn-out. Those on low temperature alarms shall fail to down scale position.

All thermocouple actuated control systems shall contain 'burn-out' protection. The design shall enable this feature to be switched in or out.

### 15.6. Temperature Switches

The temperature element of the switch assembly is to be mounted in a thermowell and the switch should be mounted on a pedestal or a stand pipe with brackets wherever applicable, su capillary type switches.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 32 of 55

The capillary tubing shall be adequately supported and clamped.

Temperature switches, locally mounted, shall be the filled system bulb type or bimetallic element. They shall meet the electrical classification and shall have micro switches. Removable thermowells shall be furnished.

Temperature switches mounted in the control room or on a local panel may be thermocouple actuated. These shall have cold junction compensation.

These switches normally are non-indicating (blind-type) or indicating-type.

- Element:

Bimetallic or filled-type, normally liquid filled.

- Mounting:

Direct mounting, unless otherwise specified in related data sheets.

- Range:

As specified in related data sheets.

- Insertion Length:

Normally is 150 mm, unless otherwise specified in related data sheets.

- Thermowell:

Normally thermowell is required, material shall be 316 S.S., or higher-grade alloy as specified in data sheet.

- Capillary (for filled-type):

Manufacturer standard capillary tube with at least 304 S.S. armour, its length shall be normally 5 meters, unless otherwise specified in related data sheets.

- Housing and cover:

Shall be die-cast aluminium.

- Electrical Classification:

Normally shall be intrinsic safety and certified by acceptable association, such as BASEEFA, unless otherwise specified.

- Switch, Electrical Requirement:

Switches shall be normally SPDT-type, or 24 VDC., 5 Amp, hermetically-sealed, according to NAMUR standard.





- Set Point Shift Due to Ambient Temperature Changes:

Shall be less than 0.1% of full scale.

- Dead Band:

Shall be less than 1% of span.

  
**ATRIN RAD MEHR**  
 سهامی خاص  
 شماره ثبت: ۴۱۴۵۵۰

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 33 of 55

- Bulb Diameter:

10 mm, unless otherwise specified in related data sheets.

- Bulb Connection:

Shall be ½ in. NPT M.

Indicating-type Temperature Switches shall be normally local mounted, dial-type, and either bimetallic or filled-system, with potential free contacts.

- Electrical Classification:

Normally shall be intrinsic safety and certified by acceptable association, such as BASEEFA, unless otherwise specified.

- Wiring:

Normally junction box shall be at right side of the switch.

Material: Black PA6-nylon, or equivalent.

Weather Protection: IP65, unless otherwise specified in related data sheets.

Ambient Temperature: In accordance with the site condition.

Entry: M20X1.5, bottom entry cable gland with retainer clamp. 4-wire + earth terminals.

Terminal Size: 2.5 mm<sup>2</sup> to accept stranded wire.

### 15.7. Filled System

Filled system may be used for following cases.

- Local indication where bimetallic type is not suitable.

In all cases the thermal bulb shall have a protective pocket and the capillary tubing of filled system shall be stainless steel, armoured plastic sheathed and flexible.

Ranges shall be selectable so that the normal indication falls within the 33% to 66% sector of the scale.





Where required, due to installation and filling medium used, thermal system shall be case and/or capillary compensated for ambient temperature changes.

Thermal bulb transmitter systems shall have an overall accuracy of ½% of the full span; all other thermal systems shall have 1% accuracy.

Tubing shall be stainless steel and protected with a stainless-steel flexible armoured covering.

Distance from bulb tip to beginning of armoured tubing is total well length plus 100mm.

Temperature sensing bulbs shall be provided with flexible extension and adjustable pressure tight union connection. Material of construction shall be stainless steel throughout.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 34 of 55

## 16. CONTROL VALVE

Control valve body material and rating shall be in accordance with the appropriate Piping and Valve Material Specification, but shall be ANSI 300# minimum rating.

The noise level shall be attenuated to a maximum of 85 dBA at one meter downstream, and one meter measured vertically from the pipe.

The material of bonnet shall be suitable to withstand the ambient temperatures and operating temperatures indicated in the datasheets.

Cable entries shall have metric threads or be supplied with adaptors to 20 mm ISO (female).

Electrical flying leads shall not be used.

Packing shall not contain any asbestos. External lubricators or grease nipples shall not be used.

Actuators shall be adequate to stroke the valve and sized based on the line rating and the maximum differential pressure to which the valve will be exposed.

Control Valves normally are fitted with pneumatic spring return diaphragm actuators. Spring and actuators shall be sized based on available supply pressure, specified in project documents.

Electric actuators may be used (subject to Owner agreement) at site locations where instrument air is not available. Note that only “fail locked” operation will be available.

“Fail open”, “Fail close” or “fail locked” modes will be determined by process or safety requirements.

A HART type positioner compatible with control system that can provide diagnostics on the operational status of the control valve trim shall be considered for all valves.





Pneumatic connections shall generally be 1/4” NPTF unless a high air capacity requirement dictates a larger size.

Local manual operation shall be provided by a side mounted hand wheel and declutching mechanism, only when specified in P&IDs.

Valve selection is generally based on application, size and cost. The globe type control valve shall be specified for the majority of applications; however, butterfly, disc or ball type valves may be considered where adverse service conditions and size requirements are more cost effective.

For each application process control shall be achieved with the valve operating between 10% and 90% open.

The minimum globe control valve body size to be used shall be 1 inch and Body sizes smaller than 1 inch may be used for special applications, for valve sizes smaller than 1 inch, reduced trim in 1 inch size bodies normally will be preferable.

 NISOC	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								 MACHINE SAZI ARAK	 SeaLand
	Instrument & Control/Safety System Design Criteria								 TR	
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 35 of 55	

Special ball valves with integral attenuator or vee port have good control characteristic and give high turndown.

Full ball valves are not recommended for slurries due to the solids settling out in the bod cavity. Valves shall be sized in accordance with ISA Standard S75.01. Certified noise calculations shall be provided for each valve.

The valve trim maximum allowable leakage rate shall be specified in accordance with the process requirements by reference to ANSI/FCI 70-2 standard and will be specified in individual data sheets.

## 17. ON/OFF VALVE

Process isolation valves and ESD valve body material and rating shall be in accordance with the appropriate Piping Material Specification.

The ESD valves shall be of fire safe type complying with the piping specification.

The process isolation and ESD valves trim maximum allowable leakage rate shall be specified in accordance with the process requirements by reference to ANSI/FCI 70-2 standard and will be specified in individual data sheets.

Single acting, pneumatic actuators with spring return to the safe position shall be employed. The type of actuator used shall be based on cost, space and weight considerations.





The valve actuators shall be sized to have 150% of the torque required to open and close the valve with an assumed maximum upstream process pressure and zero downstream pressure and with the minimum air supply.

The actuator shall have fitted adjustable stops in the open and closed position.

The piston seal configuration shall be of a fire safe design, e.g.:

- A primary elastomeric seal
- A secondary metal seal to prevent excessive leakage across the piston in case the primary seal fails due to a fire

Actuators shall be equipped with a mechanical locking device to block valves in their safe position in case equipment maintenance, repair or testing is required. The locking arrangement shall be such that accidental actuation causing movement of a valve from its safe position is not possible. This locking device shall be clearly visible when installed. The locking device shall be designed to withstand the closing force of the actuator with the maximum specified supply pressure applied. The actuator maximum possible torque under maximum supply pressure conditions shall not exceed 80% of the valve stem shear torque.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 36 of 55

A manually operated three-way valve with a lock closed facility shall be provided for each actuator to enable the valve to be closed locally and be locked closed for operations / maintenance purposes. The valve shall be provided with a stainless-steel label that shall indicate the normal and the locked positions.

Solenoid valves shall be 24VDC certified EExd. The valves shall be made from 316 stainless steel.

Unless otherwise specified all electrical equipment including solenoid valves and limit switches shall have a degree of ingress protection IP 65.

Open/Close limit switch to be considered for all ESDV to monitor valve statues on control system. Critical valves statues switches (valves which are located on site battery limits) shall be connected to ESD system as per owner request.

## 18. SELF-ACTUATED PRESSURE REGULATOR

All regulators should be installed in accordance with local and international standards and regulations.

Adequate over pressure protection should be installed to protect the regulator from over pressure, and also to protect all downstream equipment in the event of regulator failure.

The recommended selection for port diameter shall be the smallest port diameter that will handle the flow.

Spring cases must be protected against the accumulation of water caused by condensation or other sources.

Control line connections (where required) should be made in a straight run of pipe 8 to 10 pipe diameters downstream of any area of turbulence such as elbows or block valves.

Regulator body size should never be larger than pipe size. In many cases, the regulator body shall be one size smaller than the pipe size.





The self-operated regulators generally have faster response to quick flow change than pilot-operated regulators.

## 19. VALVES ACCESSORIES

Valves shall be equipped with electro-pneumatic positioners when required and shall be direct or reverse acting.

Pneumatic positioners shall have pneumatic gauges.

I/P converters shall be considered either separately or as a complete set with positioner.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 37 of 55

Control valves shall be equipped with an air set, fully tubed and tested. Air filter regulator shall be fitted with outlet pressure indicator. Also, it shall be fitted with built-in overpressure protection facility.

Control valves shall be furnished with Teflon chevron packing for temperature less than 230°C unless otherwise noted. High temperature packing shall be used above 230°C.

Pneumatic positioners shall normally be equipped with a bypass when the actuator supply pressure is the same as the control system pressure.

## 20. PRESSURE SAFETY VALVES

All pressure relief valves shall be built in accordance with the requirement of ASME.

End connections shall be as per ASME and API flanged with the rating as specified on the data sheet or screwed for sizes up to and including 2" NPT.

Safety valves shall be the standard disc and nozzle type with a guided stem, a disc holder and a closed bonnet. Soft seat valves may be used to minimize leakage. Pilot operated valves may be used.

Flanged connections shall be used in accordance with API 526, except for thermal relief valves, which will be threaded.

Valves shall comply with the pressure/temperature ratings as per requirements of ANSI B 16.5. Unless otherwise specified in individual data sheets, the inlet connection shall be rated in accordance with the set pressure and temperature.

The finish for flange facing of raised face flanges shall be 125 to 250 Ra as per ANSI B46.1.

All calibration screws shall be protected by a cap and sealing to prevent tampering.

Balanced valves shall have vented bonnets.

Thermal relief valves shall normally be 3/4" x 1" carbon steel or better for all liquids, in accordance with piping specification. Minimum orifice area shall be 0.11 square inches. Connections shall be NPT, female/female, as per ANSI B 1.20.1.

Plain lifting levers shall be provided on air or steam services.





## 21. CORROSION COUPON/PROBE/TRANSMITTER

Measurement of fluid corrosivity realized by means of coupons and probes.

Coupons and probes shall match the metallurgy of the equipment or piping as closely as possible.

Coupons and probes shall not cause turbulence in the process stream.

  
 ATRIN RAD MEHR  
 سهامی خاص  
 شماره ثبت: ۴۱۴۵۵۰

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 38 of 55

and supplier are responsible for proper operation of the complete system.

In general, design of corrosion monitoring devices shall be according to IPS-I-TP-802.

Requirements of the Corrosion Coupon/Probe/Transmitter will be described in the document Specification for Corrosion Coupon / Transmitter\_BH-17-SM-100-PI-SP-1496”.

## 22. ANALYZERS

Analyzers shall be selected from reputable manufacturers with experience in the particular analysis required and with proven experience with high reliability.

Analysis may be in-situ or extractive type which shall be finalized by the vendor, subject to the Owner approval.

If extractive type analysis is intended, it shall be designed to assure transport of the process sample to the sample conditioning system that fit the sample to the analyzer.

If necessary, the vendor must install the instrument in a cubicle to maintain the analyzer within this permissible temperature range.

The analyzer design specification shall satisfy the maximum design conditions specified for the process equipment to which it connects. Where identified as required by the vendor, the use of Pressure Reducing Stations, including pressure relief valves may be considered subject to the Client / Owner approval.

Design and construction of analyzer shall be to minimize maintenance time and maximize on-line time as far possible.

Each analyzer shall be factory calibrated for the specified span for each component.





As the fast loop and sample conditioning systems will be supplied by Vendor, he shall consider distance of sample take-off and analyzer house in his design.

Requirements of the Analyzers and relevant accessories will be described in the document “Specification for Analyzer\_BH-17-SM-100-IN-SP-1276”.

## 23. I/P CONVERTER

The I/P converter uses an electromagnetic force balance principle to change electrical signals into pneumatic signals. Typically, a 4 – 20mA input is converted into a 3 – 15psig output.

Its purpose is to translate the analog output from a control system into a precise, repeatable pressure value to control pneumatic actuators/operators, pneumatic valves, dampers, vanes,

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 39 of 55

## 24. RESTRICTION ORIFICE

Restriction orifice is normally used to drop upstream pressure of a system when process requirements lead to be utilized. While passing the fluid through the plate, energy is lost in friction and heat resulting considerable pressure drop.

Restriction orifice plate shall be the same as metering orifice plate with following exception:

- The minimum line size is 1/2"
- No weep hole is permitted.

## 25. INSTRUMENTS INSTALLATION PHILOSOPHY

All outdoor electrical instruments, local panels and JB's shall be IP 65 construction as minimum. Requirements for protection of equipment against direct sunlight shall be assessed at site and be completed. J.B material for outdoor use may be polycarbonate or equivalent, but shall comply with hazardous area requirements above.

CONTRACTOR shall apply standardized tube fittings, Swagelok or equivalent, throughout the plant.

Instrument installation is to be per IPS latest edition. All process connections shall have piping root valve.

All equipment and materials shall be new and supplied from the approved instrument vendors.

All instruments shall be provided from the latest field proven product line at the time of purchase ordering.

Contacts of the switches shall generally be, normally closed.





A non-interruptible electrical power system shall be furnished for operation of all instrumentation & equipment in the plant.

Care shall be taken to ensure that no passage ways or access to equipment is obstructed by instrument installation. Instrumentation requiring operator access should be mounted at a level of 1400 mm from grade or plat form. Direct process connected devices such as level switches, displacers, thermowells etc. should have additional support if necessary.

Field indicators shall be provided so that they are visible from the associated control valve or final element, unless otherwise noted on P&IDs or other applicable documents.

Handrails shall not be used for mountings or supporting instruments.

Instrument field supports, J.B frames etc shall be sufficiently prepared and finished. Support brackets shall be dip-galvanized mild steel.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 40 of 55

All instruments shall be mounted and supported so that it is free from vibration and misalignment.

## 25.1. Instrument Cabling and Wiring

Main instrument cables from control room to field JBs shall run under ground where possible. Contractor shall clarify the cable route according to existing cable trench routs. Any change of main cable route at later date shall be subject to the approval by the Owner.

Suitable seal at cable entrance shall be provided at cable entry to all buildings or houses. The 20% of spare cable entrance shall be installed.

Multicore cables shall be sized to contain min. 20 % spare conductors at the issue of cable connection list as For Construction.

Intrinsically safe circuits and non-intrinsically safe circuits shall not be contained within the same cable, junction box and marshalling racks. I.S and non-I.S cables may run together in the same tray or trench but shall properly be segregated.

Instrument analog signal cables shall be routed separately from electrical cables. The physical separation of signals and power cables on parallel runs shall follow IPS-E-IN-190 and API RP 552.

Instrument cables shall not run on the same trays as instrument piping and tubing.





Cables shall only be terminated in instruments, junction boxes or other approved equipment. The intermediate cable joint shall be avoided.

### 25.1.1 Underground Cable Installation

The multi core cables shall be installed in underground as principal. The underground cable shall be run in concrete trenches at paved area and in direct buried at unpaved area.

Instrument cables and electric power cables with voltage more than 230V AC shall not be installed in the same trench except for optical fibre cables. The separator shall be installed between instrument cables and power cables (230 VAC) where both cables are installed in the common trench. The separator shall be grounded to plant earth. Optical fiber cables may be installed in the same trench as power cables with minimum distance of 10cm.

All removable concrete slabs covering the trenches shall be color-coded. Crossing beneath roads shall be by means of ducts encased in concrete. The route of all main trenches shall be shown in detailed drawing based on the typical cross section of cable trench drawing by Contractor.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 41 of 55

### 25.1.2 Above Ground Cable Installation

All of branch cables should be installed in ladder racks, cable trays or conduits. The ladder rack should be used for large routes and cable trays shall for the small (below app. 200-mm width).

Unprotected supports shall be painted prior to cable installation.

Supports for ladder rack and tray shall be fixed to suitable structure steel and concrete, before the application of any fireproofing. Welding is preferred method of fixing to structure steel. Galvanizing shall be repaired after welding. Supports shall be not welded to pipe work.

Cable tray or cable ladder cover shall be installed where they are installed on the top of cable structure, vertically installed or exposed by direct sun shine. The covers will be hocked on the tray or ladder for cable maintenance.

Individual cable runs near to the final termination point, such as individual field instrument shall be run in open conduit.

Above ground cables shall be fixed using stainless steel tie band, pre-formed saddles or Stainless-steel strapping. Cables should be fixed at approximately 250mm interval in vertical runs and 500-mm intervals on horizontal runs.

Cables connected to instruments shall be installed with a loop of cable to provide sufficient slack for re-marking the cable connection if the instrument is removed and to allow for removing the instrument without electrical disconnection.

## 26. CONTROL AND MONITORING SYSTEM

### 26.1. Programmable Logic Controller (PLC)






The main control system shall be based on a PLC and redundant according with IPS recommendations. The monitoring and diagnostic interface between the operator and the control system shall be through a HMI system, communicating to the PLC though an Industrial Ethernet network.

A control system shall be used for process control and to provide operator with the ability to perform all control and monitoring functions. This approach allows all process measurements and alarm/status inputs to be wired to control and data acquisition devices.

Each control system shall provide the following functionality as a minimum:

- Graphic Displays at both overview and detailed levels.
- Alarm listing displays.

  
**ATRIN RAD MEHR**  
 سهامی خاص  
 شماره ثبت: ۴۱۴۵۵۰

 NISOC	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								 MACHINE SAZI ARAK	 SeaLand
	Instrument & Control/Safety System Design Criteria								 TR	 ENGINEERING AND WELL SERVICES
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 42 of 55	

- Loop configuration displays.
- Displays for special signals groupings
- Current and historical trend displays.
- Alarm & event logging.
- Data storage and archiving.
- Report generation.
- Hard copying (screen prints, paper reports).

New Control system (PCS) will be connected to new ESD as well as new F&G system by means of a redundant Modbus serial link. Process parameters of the ESD and F&G shall be available in the PCS for indicating on the monitoring system.

Required signal transferring between new and existing PCS will be carried out in accordance with the process requirement as will be specified and finalized in the P&IDs.

Philosophy of interconnecting between process control system (PCS) and mechanical packages will be declared and finalized in the documents "Control / ESD / F&G System Overall Block Diagram for Bibi Hakimeh No.2\_ BH-17-SM-100-IN-BD-0706-D00" and "Control / ESD / F&G System Overall Block Diagram for Nargesi\_ BH-18-SM-100-IN-BD-0119-D00".

PLC system will be detailed in "Specification for Control System\_ BH-17-SM-100-IN-SP-0057".

## 26.2. Emergency Shutdown (ESD) System

Instrumentation shall be designed and selected for a fail-safe condition i.e. loss of instrument air or power supply shall not impair the safety of the process. Shut-down initiation devices contacts shall be closed and circuit energized, under normal operating conditions (fail safe conditions), except where safety consideration and/or power sources reliability necessitate another form.





All shut-down causes shall be preceded by preventive signals which initiate from other initiating device.

Instruments for ESD signal shall be independent of other instruments.

ESD shall provide critical interlock and shall cause shutdown by manual push buttons or automatically, based on potentially dangerous abnormal condition detected by a field sensing device(s).

The ESD System shall be arranged in suitable redundancy according to SIL3.

ESD system will be connected to Control system (PCS) by means of a redundant Modbus serial link. Process parameters of the ESD system shall be available in the PCS for indicating on th

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 43 of 55

monitoring system.

The signals required to transfer between new and existing ESD will be realized in accordance with the process requirement as will be specified and finalized in the P&IDs.

Emergency Shutdown (ESD) System will be detailed in “Specification for Emergency Shutdown System\_ BH-17-SM-100-IN-SP-0058”.

### **26.3. Fire and Gas Detection Systems**

The Fire & Gas Detection Systems shall be provided with the following objectives:

- To monitor the plant for fire condition or gas leakage.
- To activate the related audible and visible alarms in case of fire & gas hazard.
- To indicate the location of the hazard on dedicated fire & gas alarm panels in order to trace the hazard.
- To perform executive actions (fire pumps, shutdown activation, etc.), as required.

The Fire & Gas Detection Systems shall be chosen to provide the user with safe, efficient and reliable equipment of proven design using fail safe principles.

The Fire & Gas Detection systems shall employ a Programmable Electronics System with a system architecture complying with the requirements of IPS-G-IN-270.

The F&G I/O modules shall be redundant.

The Fire & Gas Detection Systems shall be arranged in suitable redundancy according to SIL3. (The PLC for conventional devices and may be addressable panel for addressable devices).

Addressable fire alarm control panel shall be used for addressable devices. FACP shall be suitable for installation in safe indoor environment (IP-54). FACP shall be equipped with programmable solid stated controller. FACP shall be designed for deriving addressable detectors on the at least four separate loops with more than 64 devices on a loop.





FACP shall be provided with MODBUS RTU for connection to the F&G main control system.

The status of each loop and general fault shall be hardwired to FGS.

Flammable gas sensors shall be installed where flammable liquid or gas may accidentally leak or accumulate. Toxic gas sensors and hydrocarbon sensors are installed at locations where the toxic gases or HC's have the potential to leak or accumulate.

Manual call points, heat and smoke detectors shall be installed at buildings and locations that are subject to fire hazard. These contacts and detectors shall be connected to dedicated Fire & Gas panel(s) in the Control Rooms and / or the Fire Stations, as required.

Hardwire connection shall be used between the Fire & Gas Detection System ESD.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 44 of 55

Modbus Redundant shall be used between the Fire & Gas Detection System the Process Control System to perform executive actions, as required.

The Fire & Gas Detection system shall be electrically powered from the 24 VDC power supply which is totally independent and provided by battery for a period of 24 hours back-up (24 hours back up for system normal operating without alarming devices and at the end of this time 5 minutes for activation of all alarming devices). Battery charging shall be automatic, with double battery chargers.

In plant areas flame detection will be by triple IR bandwidth detectors.

Gas detection will be by UV point type and open path beam detectors. Reflector screens shall not be used for the open path detectors.

The IR flame and UV gas detectors shall be EEXd rated units. They will provide a 4-20mA signal that will include a fault alarm and have diagnostic facilities that will include beam blocked/obscured optics

In areas the MACs, heat and smoke detectors shall connect to the F&G unit by hardwire input of two 50% loops per fire zone.

The basis of F&G detection is described in F&G philosophy.

The F&G system shall generate all necessary alarm outputs for the zones-fire, fault, etc, and these shall be routed to the Control System (PCS) via data links. The PCS shall log all FGS events, and these shall be visible at the relevant PCS Consoles, in the CR.

All interconnections between FGS with PCS to monitoring of alarms and events shall be via a redundant Modbus serial link.

The signals required to transfer between new and existing F&G system will be realized in accordance with the safety requirement as will be specified and finalized in Safety documents such as F&G C&E.





Fire and Gas Detection System will be detailed in “Specification for Fire & Gas System\_ BH-17-SM-100-IN-SP-0059”.

#### **26.4. Interposing Relay Panels (IRPs)**

The interposing panel serves as the interface between plant Motor Control Centres (MCC's) and control system(s).

I/O signals between control system(s), MCC and IRPs to be considered as non-hazardous. IRP shall be located at MCC Room.

IRP discrete signals to/from control system, MCC and Package PLC (if any) will be free vol

 NISOC	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								 MACHINE SAZI ARAK  SeaLand  TR 
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 45 of 55

Contact.

The panel may provide both marshalling and interposing aspect at the same enclosure, signals between control system(s) and MCC / switchgears shall be adjusted according to different voltage level.

Interposing Relay Panels (IRPs) will be detailed in “Specification For IRP Panel \_BH-17-SM-100-IN-SP-1569”.

## 27. INSTRUMENT REQUIREMENTS INSTALLED IN THE CONTROL BUILDINGS

The instruments in the control buildings will be installed in safety area and under air-conditioned environment.

For PLC/ESD cabinets and operator consoles Manufacturer and Owner standard shall be applied.

Consideration shall be given for the uniformity in appearance for these cabinets, racks and consoles.

All cabinets/racks etc. shall have bottom cable entries. Bottom plates shall be removable for cable installation. Steel bar(s) shall be provided to fix the external cables at the bottom. The mounting arrangements for cabinets shall take into account the sealing requirements for the extinguishing gas system below the raised floor.

Maximum use should be made of plug and socket connections between the cabinets.

The free access raised floor shall be provided for installation of cabinets and consoles.

Redundant ventilation fans shall be installed where it is required.

### 27.1. Auxiliary Cabinets

Auxiliary cabinets shall be of sheet steel, enclosed type with doors at the front and rear side.

These cabinets shall be as far as possible uniform in appearance with the PLC cabinets.





At least 20% hot spare terminals or connecting pins on system sockets shall be provided at FAT.

Terminals to accept field cables shall be klippon type or equivalent.

All terminals/pins shall have terminal/pin numbers and each wire shall have circuit identification markers by using sleeve or plastic ferrules at all termination points.

All internal wiring shall be laid in the PVC trunking with covering lid or bundled for small quantity.

Removable cover plates shall be provided for all terminals with voltages above 50 volts.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 46 of 55

When instruments are provided with screw type connecting terminals, the wire ends for multistranded wires shall be provided with crimped-on spade lugs.

All electrical devices shall be mounted in such a way that positive earthing is assured by metal-to-metal contact to the cabinet. Each cabinet shall be provided with a suitable earthing bolt for bonding.

A nameplate shall be provided on the front face of the cabinets and for instruments inside the cabinet.

A pocket with wiring drawings shall be provided.

## 28. INSTRUMENT CABLES

Instrument Cables shall be in accordance with the relevant applicable IPS-E-IN-190, IPS-M-IN-190, IPS-C-IN-190 recommendations and with the regulation of the country of installation.

All cables will be as detailed in "Specification for Instrument/F&G Cables\_ BH-17-SM-100-IN-SP-0060". This specification gives details of cable type, cable categories and service applications.

All cable shall be protected against mechanical damage, chemicals, radiation (solar) and heat.

Flame retardant cables shall be used for instrument cables as a minimum requirement.

All FGS and ESD system Cables shall be fire resistance according to IEC 60331.

Suitable seal at cable entrance shall be provided at cable entry to all buildings or houses. The 20% of spare cable entrance shall be installed.

Intrinsically safe circuits and non-intrinsically safe circuits shall not be contained within the same cable, junction box and marshalling racks. I.S and non I.S cables may run together in the same tray or trench but shall properly be segregated according with IPS-C-IN-190.





Instrument cables shall not run on the same trays as instrument piping and tubing.

Cables shall only be terminated in instruments, junction boxes or other approved equipment. The intermediate cable joint shall be avoided.

The multi-pair cables shall be installed underground as principal. The underground cable shall be run in trenches.

The separator shall be installed between instrument cables and power cables where both cables are installed in the common trench according with IPS recommendations. The separator shall be grounded to plant earth.

Where instrument cables are to be pulled through conduit, the conduit shall be completely dry prior to installation and the ends shall be temporarily sealed to prevent entrance of moisture

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 47 of 55

rain during installation.

All conduits shall be fastened with pipe clamps or U-bolts, and shall not be tack welded. Substantial steel hangers shall be provided for groups of conduits where it is not practicable to clamp directly into building walls or structural members.

Thermocouple extension wires may be run in conduits. If the wire is run in conduit, vapor proof fitting shall be used. A loop of flexible conduit shall be used, when attaching conduit to thermocouple heads.

All cables in the field shall be glanded.

The following general requirements are applicable to all gland installations:

- All glands shall comply with its electronic hazardous protection and maintain the IP rating of the associated equipment.
- The gland tread shall match that of associated equipment.
- The use of thread adapters shall be minimized.

Every instrument cable and junction box is allocated a number. All these number shall be shown on the detailed drawings and are marked on cables, wires and junction boxes.

## 29. JUNCTION BOXES





Junction box shall be designed to be suitable for hazardous area classification; EExd certified metal box with IP 65 as minimum. The minimum 20 % spare terminals shall be provided for incoming multi core cables. All junction boxes shall have a stainless steel name plate installed on its outside surface and an external earth bolt.

Junction box including analogue signals shall have overall screen and individual screen terminals. The terminal shall be labelled in serial numeric number. The number of hubs for branch cables with corresponding to its multi core cable shall be provided. All spare hubs shall be plugged.

Internal earth/ screen rail shall be provided. Only bottom gland connections are acceptable. Breathers shall be provided to reduce internal condensation. Laminated terminal drawings shall be supplied in each junction box. Cable glands shall be provided for the cables terminated in the J.B.

## 30. INSTRUMENT EARTHING

The earthing of measurement, control and computer systems shall be arranged to pre electrical interference. Particular attention shall be given to the arrangement of earthing cir

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 48 of 55

to prevent unwanted circulating currents in earthing, signal and measurement conductors and screens.

All electrical devices shall be grounded to protect personnel and equipment against electrical discharge.

Up to three grounding circuits shall be provided as follows:

1. Primary earth ground used for:

- All cable armors
- Instrument housing
- Instrument equipment supports

Cable trays

2. Intrinsically safe barriers ground reference

3. Clean Earth:

The instrument earthing system shall be isolated from the other earthing systems and maximum grounding resistance shall not exceed 1  $\Omega$ .

## 31. INSTRUMENT INSPECTION AND TESTING PHILOSOPHY

### 31.1. General

The Vendor's quality plan shall include a comprehensive fully documented inspection and testing plan specific to the project.

The procedures shall include inspection specifically for compliance with hazardous areas requirements, including current certificate, without which no circuit or loop shall be energized.

All testing, calibration and pre-commissioning shall be done by the Contractor.





The Contractor shall also provide assistance as required during commissioning activities.

The Contractor shall provide suitable workshop facilities and shall provide all necessary test and calibration instruments and equipment.

The Owner reserves the right to reject any or all test and calibration work if found not complying with the Specification requirement. The Contractor shall complete and submit documentation for all calibration, testing and pre-commissioning.

Owner Representative prior to shipment shall check out panels, consoles, and packaged instrument assemblies for their compliance with specification requirements.

The Contractor shall in the presence of the Owner representative, verify by inspection, calibr and loop testing, that, all instrumentation in field and control room including local

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 49 of 55

remote/central control panels, are complete and operable as per specification requirement. All testing and calibration shall be subject to approval of the Owner.

In addition to calibration/testing, loop checking, setting for safety devices like process switches, safety valves etc. and simulation testing of all interlock and shutdown systems, done at fabrication yards.

In general, the pipes and tubes shall be cleaned before testing. They shall then be subject to hydrotest (or other applicable tests) and then blow dried.

### **31.2. Flushing of Lines**

The Contractor shall remove in line instruments like flow meter, control valves/safety valves, if necessary, and provide spool pieces/flanges prior to flushing of lines.

### **31.3. Instrument Supply Lines**

Instrument air/gas piping and tubing shall be disconnected upstream of all filter/regulators before testing, the piping and tubing shall then be hydro tested as explained below and then shall be blown down to remove hydro test water, slag and mill scale from lines.

Instrument air supply lines shall be blown with instrument air prior to connecting to instruments. Instrument air/gas mains shall be isolated from the instrument and pressurized to 11/2 times maximum working pressure with instrument air, they shall be isolated from the pressure source and the pressure reading on a test gauge shall not fall by more than one psig in ten minutes.





### **31.4. Instrument Signal Lines**

Instrument signal lines shall be blown with instrument air prior to connecting to instruments. All air/gas tubing shall be tested and inspected by one of the methods given in Instrument System & Automation Society (formerly known as Instrument Society of America) "ISA 7.0.01 \_Quality Standard for Instrument Air". Clean, oil free instrument air shall be used for the test.

### **31.5. Impulse Lines**

All process impulse lines shall be disconnected and flushed with potable water.

Air lines shall be blown down with filtered air. Hydraulic lines shall be flushed with hydraulic oil. After flushing process impulse lines shall be isolated from the instrument and pressurized hydraulically to 11/2 times maximum working pressure corrected for ambient temperature. They shall then be isolated from the pressure source and the pressure reading on a test gauge shall fall at a rate exceeding one psig/hour.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	Instrument & Control/Safety System Design Criteria								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 50 of 55

### 31.6. Direct Mounted Instruments

For direct mounted instrument such as level gauges, level transmitters (displacer type), level switches etc., and the installations shall be pressurized to maximum operating pressure slowly and steadily with the instruments. The installations shall then be isolated from main pressure source. The pressure shall not fall at a rate exceeding one psig/hr.

### 31.7. Wiring

Wiring shall be checked to ensure that it is correctly connected and properly grounded. Insulation test shall be carried out on all wiring taking necessary precautions. Correct connections of all electric or pneumatic switches shall be checked.

### 31.8. Calibration & Testing





The Contractor's instrument personnel shall calibrate instruments. This calibration shall when possible, be done with the instrument or system in place, otherwise calibration prior to installation or removal for calibration shall be done. The Contractor shall provide written results of all instrument calibration in prescribed format and shall submit such formats well in advance for Owner's approval. The status/progress of testing calibration for each loop shall be reported to the Owner. The Contractor shall submit document confirming that the testing equipment to be used for calibration purpose are certified and calibrated.

In general, all tests shall simulate, as closely as possible, design process conditions by use of manometers, potentiometers, deadweight testers, and test pressure gauges, etc. utilizing hydraulic and pneumatic suppliers. Three (3) point calibrations shall refer to the input signal to an instrument equivalent to 0, 25, 50, 75 and 100 per cent of the instrument range upscale (rising) and 75, 50, 25 and 0 percent of the instrument range downscale (falling). All instruments, unless otherwise noted, shall be calibrated in both upscale and downscale directions and, if necessary, adjusted until their accuracies conform to those limits stated by the manufacturer. Upon completion of these tests, the instruments shall be drained, the components removed and the shipping stops replaced. Wherever applicable, the instruments shall be subject to NDT / Dye penetration test.

### 31.9. Testing and Calibration Report

The Contractor shall provide written results of all above tests and if required by the O provide reasonable evidence of the satisfactory condition of test equipment.

  
**ATRIN RAD MEHR**  
 سهامی خاص  
 شماره ثبت: ۴۱۴۵۵۰

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 51 of 55

All errors of faulty workmanship discovered during this testing shall be corrected to the satisfaction of the Owner.

Note: The installation and testing requirements of individual instruments / systems shall be as per the relevant Functional Specification.

### 32. INSTRUMENT SPARE PHILOSOPHY

For all major equipment, in accordance with owner commissioning and two years spare part procedure the C contractor shall include normal commissioning spares as a part of the equipment. The C contractor shall also furnish separately, list of recommended spares for two year's trouble free operation along with the prices for purchaser's review.

All spare parts shall comply with the same standards and specifications as the original equipment and shall be fully interchangeable with original parts.

All spare parts shall be marked with the manufacturer's part number, name and / or reference number.

All spare parts shall be packed separately from the main instrument, and shall be properly protected to prevent deterioration and damage during shipment and storage.

Note: The spares requirement of individual systems shall be as per the relevant functional specification.

### 33. PACKING AND SHIPMENT





Instruments or parts, which can be damaged during shipment, shall be packed separately in the original manufacturer's boxes. Each package shall be identified with purchase order number and content list in a weatherproof envelope.

All opening shall be sealed. Threaded connections shall be protected with forged steel or molded plastic screwed plugs.

All flanged openings shall be protected with wood or steel closures attached by proper bolting and sealed with a plastic compound to exclude foreign material from the interior and fully protect the flange faces.

All mechanical or machined surfaces subject to atmospheric corrosion prior to installation on site shall be treated with an easily removable rust preventative.

A desiccant shall be provided inside all enclosures to prevent moisture damage due to humidity.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 52 of 55

Any plant component exceeding 40 Kg in weight shall be supplied with lifting lugs or eye bolts. The lugs or eyebolts should be positioned such that the component can be readily slung from a point over its center of gravity.

All items shall be properly packed and protected from damage during shipment.

Any instrument on packaged equipment, which could possibly be damaged during shipment shall be disassembled and removed. The disassembled instruments shall be packed and shipped with the package or packaged equipment. All openings shall be suitably sealed.

The electronic and electrical components removed from package-mounted panel shall be shipped independently. The shipping notice shall be written on the box or crate with red letters, such as "Handle with Care" / "Keep Dry" / "Fragile", etc.

A suitable desiccant shall be placed inside those control panels or junction boxes, which contain electronic or electrical components during shipment.

Each crate, bag or package shall be clearly identified with the purchase order number and identification symbol.

The Contractor shall be solely responsible for the adequacy of the Preparation for shipment in his Tender for review by Owner. Contractor shall also state in the Tender his recommendations for long term storage (up to 12 months) for both indoors and open air storage.

It is Contractor's responsibility to reassemble the instruments disassembled during shipment after the packages or packaged equipment are positioned and installed on site.





## 34. DOCUMENTATION

### 34.1. Equipment Documentation

The Contractor or Vendor shall provide the following documents as a minimum, if required:

- Operating philosophy of the system
- Equipment specifications
- Catalogues
- Data sheets
- Test certificates
- System layout drawings
- Functional schematic
- Bill of material / material take off for bulk materials

  
**ATRIN RAD MEHR**  
 سهامی خاص  
 شماره ثبت: ۴۱۴۵۵۰

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 53 of 55

- Instrument layout & cable tray routing drawings
- Instrument calibration procedures
- Cable schedule
- Instrument & Junction box location plans / layouts
- Loop schematics
- Interconnection diagrams
- Cable termination details
- Installation standard drawings
- Air supply header and distribution drawings
- Junction box wiring scheme
- Field calibration and loop checking report
- As-built drawings





The purchase documents submitted for Owner's review / approval shall have the following documents as a minimum, if required:

- Top sheet identifying the document number and duly signed by the Contractor
- List of Commissioning Spares – duly signed by the Vendor and Contractor
- List of two year spares – duly signed by the Vendor and Contractor
- Inspection Requirement Table – duly signed by the Vendor and Contractor
- Instrument / Equipment specifications
- Catalogues
- Duly filled data sheets, signed by the Contractor
- Test certificates
- Functional schematic (as applicable)
- Bill of material / material take off for bulk materials
- Instrument calibration procedures
- QA / AC Plan

The Contractor shall provide a dossier of all hazardous area equipment, containing all information pertinent to the hazardous area work. The dossier shall include all necessary certificates, drawings, calculations, catalogue information, data and specification sheets, etc.

All issued documents will be submitted in Hard Copy according to coordination procedure

Minimum 4 (four) sets of Dossier shall be provided to the Owner.

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 54 of 55

The contractor shall be responsible for the authenticity of the drawings & data provided by the vendor as well as sub-vendor(s).

Each vendor data items requested above must be identified by the Purchase Order number and equipment tag number located on the cover sheet or first page of said item and in the case of engineering drawings on each and every drawing.

Any additional data/drawings required as a result of issuing supplements to a purchase order or during detailed engineering shall be furnished by Vendor and handled in the same manner as the original order.

All drawings and literatures shall be in English language and in the Metric Measurement System. The reproducible drawings, 297mm X 420mm (11.7" x 16.5") size and full size are to be of such quality that clear legible prints can be made with Osolid type reproduction facilities.

### **34.2. Instrument Index**

The contractor shall provide an Instrument Index.





The index shall include the information listed below:

- Instrument Tag Number
- Service Description
- Vessel / Line details
- Operating pressure / temperature / flow / level parameters
- Manufacturer / Model
- Range / Calibrated Range
- Reference Piping and Instrument Diagram Drawing Number
- Data Sheet Number, With Latest Revision
- Location Of Instrument (i.e. Field, Control Panel)
- Remarks Column

The instrument index shall form the basis for documenting all instrumentation and shall be listed in alphanumeric order of instrument tag number and shall contain all relevant information for each instrument. The index shall be based on spreadsheet.

### **34.3. Instrument Data Sheet**

A duly filled data sheet shall be provided for every item of instrumentation equipment, including those which are part of equipment packages, except those items which form part of the

 <b>NISOC</b>	<b>Development Plan of 28 Reservoirs / BIBI HAKIMEH Oilfield (EPC)</b>								  
	<b>Instrument &amp; Control/Safety System Design Criteria</b>								
Contract No.: 053-073-9189	Project BH	Package 17	Contractor SM	Fac. 100	Disc. IN	Doc. Type DC	Ser. No. 0052	Rev. D02	Page 55 of 55

material take-off. These specification sheets shall be according to relevant ISA standards and shall contain all information pertaining to a particular instrument including:

- Manufacturer Model
- Mechanical Details
- Electrical Details
- Materials
- Process Data (where required)
- Range

Hazardous area classification and certificate details (type of protection, certifying authority)

Line or Vessel Number and Tag Number

When a number of items are identical in their requirements, these can be covered by a single specification sheet, provided all tag numbers are clearly listed.

The Contractor shall submit his proposed data sheet for Owner approval.

#### **34.4. Instrument Calculations**

The Contractor shall provide certified calculations for instruments, including those listed below:

- Shutdown valve stroking time
- Flow element sizing
- Restriction orifice sizing and stress analysis

These shall form part of the relevant Purchase Specification to be submitted during Detailed Engineering.

Note: The As Built documents shall be provided by contractor and Owner approval.

  
**ATRIN RAD MEHR**  
 سهامی خاص  
 شماره ثبت: ۴۱۴۵۵۰