



**MR 226/2017**

**PREFERRED SUPPLIER for  
INTELLIGENT ELECTRONIC DEVICES (IEDs)  
for  
POWER SYSTEM PROTECTION and CONTROL**

**FIJI ELECTRICITY AUTHORITY**

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# REVISION HISTORY & DOCUMENT CONTROL

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# TABLE OF CONTENTS

<b>REVISION HISTORY &amp; DOCUMENT CONTROL .....</b>	<b>2</b>
<b>1 INTRODUCTION AND SCOPE OF WORK .....</b>	<b>5</b>
<b>2 INSTRUCTIONS TO BIDDERS.....</b>	<b>6</b>
2.1 Eligible Bidders.....	6
2.2 Eligible Materials, Equipment and Services .....	6
2.3 One Bid per Bidder .....	6
2.4 Cost of Bidding .....	6
2.5 Site Visits.....	6
2.6 Contents of Bidding Documents .....	6
2.7 Clarification of Bidding Documents.....	7
2.8 Amendment of Bidding Document.....	7
2.9 Language of Bid .....	7
2.10 Bid Prices .....	7
2.11 Bid Currencies .....	7
2.12 Bid Validity.....	8
2.13 Format and Signing of Bids .....	8
2.14 Sealing and Marking of Bids.....	8
2.15 Deadline for Submission of Bids.....	9
2.16 Late Bids.....	9
2.17 Modification and Withdrawal of Bids.....	9
2.18 Rejection of One or All Bids.....	9
2.19 Process to be Confidential.....	9
2.20 Clarification of Bids.....	10
<b>3 GENERAL CONDITIONS OF CONTRACT .....</b>	<b>11</b>
<b>4 CONDITIONS OF PARTICULAR APPLICATION .....</b>	<b>11</b>
<b>5 REFERENCES .....</b>	<b>16</b>
5.1 Applicable Standards.....	16
5.2 Applicable Laws.....	17
<b>6 GENERAL REQUIREMENTS .....</b>	<b>18</b>
6.1 Service Conditions.....	18
<b>7 DESIGN AND PERFORMANCE CRITERIA.....</b>	<b>19</b>
7.1 General.....	19
7.2 Power Supply and Monitoring.....	19
7.3 Current Transformer Inputs .....	19
7.4 Voltage Transformer Inputs .....	20
7.5 Control Inputs .....	20
7.6 Control Outputs .....	20
7.7 Earthing .....	21
7.8 Communications.....	21
7.9 Time Synchronizing .....	21
7.10 Operator Screen .....	21
7.11 Programmable Operator Controls .....	22
7.12 Metering, Event Reporting and Special Reports .....	22
7.13 Frequency and Phase Rotation .....	22
7.14 Processing Capabilities and Storage.....	23
7.15 Self-Monitoring .....	23
7.16 Software Package .....	23
7.17 Access Controls and Security.....	23
7.18 Protection, Control and Monitoring Functions .....	24
7.19 Automation and Logic Functions .....	24

7.20	Design Reviews and Factory Inspections.....	24
<b>8</b>	<b>TESTING.....</b>	<b>25</b>
8.1	Testing Obligations.....	25
8.2	Type Tests.....	25
8.3	Routine Tests .....	26
8.4	Witnessing of Tests .....	26
8.5	Test Certificates.....	26
<b>9</b>	<b>RELIABILITY .....</b>	<b>27</b>
9.1	Service Life.....	27
9.2	Spare Parts and Maintenance.....	27
9.3	Evidence in Support of Reliability.....	27
<b>10</b>	<b>ENVIRONMENTAL CONSIDERATIONS.....</b>	<b>27</b>
<b>11</b>	<b>PACKAGING AND MARKING.....</b>	<b>28</b>
<b>12</b>	<b>QUALITY REQUIREMENTS .....</b>	<b>28</b>
12.1	Quality System .....	28
<b>13</b>	<b>STOCK AVAILABILITY.....</b>	<b>28</b>
<b>14</b>	<b>PRODUCT WARRANTY PERIOD .....</b>	<b>28</b>
<b>15</b>	<b>INFORMATION TO BE SUPPLIED BY THE BIDDER .....</b>	<b>29</b>
15.1	Documentation to be Supplied with the Tender.....	29
15.2	Samples.....	29
15.3	Training.....	29
<b>APPENDIX 1:</b>	<b>REQUIRED PROTECTION, CONTROL AND MONITORING FUNCTIONS.....</b>	<b>32</b>
<b>APPENDIX 2:</b>	<b>DEPARTURE FROM SPECIFICATIONS .....</b>	<b>37</b>

# 1 INTRODUCTION AND SCOPE OF WORK

Fiji Electricity Authority (“FEA”) is responsible for generation, transmission and distribution of electricity in Viti Levu, Vanua Levu, Ovalau and Tavueni in Fiji. By the end of 2016, the FEA had 174,530 customers. This included residential, commercial and institutional customers.

FEA operates five independent power systems on the islands of Viti Levu, Vanua Levu, Ovalau and Taveuni. It has 9,246km of 11kV and 415V electricity distribution lines, 534.86km of 33kV sub-transmission lines and 147.2km of 132kV transmission lines. It has twenty (20) power stations and forty (40) sub-transmission switching stations and zone substations.

It has over 1000 protection relays installed in its power stations, switching stations and zone substations, majority of which are numerical or digital type, for protection of its electricity generation, transmission and distribution networks.

FEA is seeking tender bids from reputable manufacturers and suppliers for design, manufacture, testing and supply of intelligent electronic devices (IEDs) for electrical protection and control of its electricity generation, transmission and distribution networks.

The tenderer shall state any non-compliance with the specification in the tender submission using the forms in the Appendices. FEA reserves its right to accept or reject any non-compliance.

## **2 INSTRUCTIONS TO BIDDERS**

### **2.1 Eligible Bidders**

This invitation is open to all Bidders who have sound Financial Background, and have previous experience in design, manufacture, testing and supply of such IEDs.

Bidders shall provide such evidence of their continued eligibility satisfactory to FEA as FEA shall reasonably request. Bidders who are not manufacturers of such IEDs shall provide evidence of agency.

Bidders shall not be under a declaration of ineligibility for corrupt or fraudulent practice.

### **2.2 Eligible Materials, Equipment and Services**

The materials, equipment, and services to be supplied under the Contract shall have their origin from reputable companies as specified by FEA and from various countries and all expenditures made under the Contract will be limited to such materials, equipment, and services. Upon request, bidders may be required to provide evidence of the origin of materials, equipment, and services.

For purposes of this Contract, "services" means the works and all related services including design services.

For purposes of this Contract, "origin" means the place where the materials and equipment are mined, grown, produced or manufactured, and from which the services are provided. Materials and equipment are produced when, through manufacturing, processing or substantial or major assembling of components, a commercial recognized product results that is substantially different in basic characteristics or in purpose or utility from its components.

The materials, equipment and services to be supplied under the Contract shall not infringe or violate any industrial property or intellectual property rights or claim of any third party.

### **2.3 One Bid per Bidder**

Each bidder shall submit only one bid. A bidder who submits or participates in more than one bid will cause all those bids to be rejected.

### **2.4 Cost of Bidding**

The bidder shall bear all costs associated with the preparation and submission of its bid and FEA will in no case be responsible or liable for those costs.

### **2.5 Site Visits**

No site visits are required for this project.

### **2.6 Contents of Bidding Documents**

The bidder is expected to examine carefully the contents of this Bidding document. Failure to comply with the requirements of bid submission will be at the bidder's own risk. Bids which are not substantially responsive to the requirements of the bidding documents will be rejected.

## **2.7 Clarification of Bidding Documents**

A prospective bidder requiring any clarification of the bidding documents may notify FEA in writing by fax (hereinafter the term "fax" is deemed to include electronic transmission such as facsimile, cable and telex), or email addressed to:

Tuvitu Delairewa  
General Manager Commercial  
2 Marlow Street, Suva, FIJI.  
Phone: 679 3224 185  
Facsimile: 679 331 1882  
Email: [TuvituD@fea.com.fj](mailto:TuvituD@fea.com.fj)

FEA will respond to any request for clarification which it receives earlier than 10 days prior to the deadline for submission of bids.

## **2.8 Amendment of Bidding Document**

At any time prior to the deadline for submission of bids, FEA may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective bidder, modify the bidding documents by issuing addenda.

## **2.9 Language of Bid**

The bid, and all correspondence and documents related to the bid, exchanged between the bidder and the FEA shall be written in the English language.

## **2.10 Bid Prices**

Unless specified otherwise, Bidders shall quote for the entire facilities on a "single responsibility" basis such that the total bid price covers all the Supplier's obligations mentioned in or to be reasonably inferred from the bidding documents in respect of the design, manufacture, including procurement and subcontracting (if any), testing and delivery.

Bidders shall give a breakdown of the prices in the manner and detail called for in this bidding document, or any issued addenda.

Bids shall be given on CIF or CPT basis. The point of delivery shall preferably be FEA's Navutu Depot in Lautoka. The term CIF or CPT shall be governed by the rules prescribed in the current edition of Incoterms, published by the International Chamber of Commerce, Paris.

## **2.11 Bid Currencies**

Prices shall be quoted in a single currency only.

## 2.12 Bid Validity

Bids shall remain valid for a period of **180 days** from the date of Deadline for Submission of Bids specified in Sub-Clause 2.15.

## 2.13 Format and Signing of Bids

The bidder shall prepare one original and four (4) copies of the technical and financial proposals, clearly marking each one as: "ORIGINAL-TECHNICAL & PRICE PROPOSAL", "COPY NO. 1 - TECHNICAL & PRICE PROPOSAL", etc. as appropriate. In the event of discrepancy between the original and any copy, the original shall prevail.

The original and all copies of the bid shall be typed or written in indelible ink (in the case of copies, Photostats are also acceptable) and shall be signed by a person or persons duly authorized to sign on behalf of the bidder. All pages of the bid where entries or amendments have been made shall be initialed by the person or persons signing the bid.

The bidder shall provide one electronic copy of the Technical and Financial proposals on FEA's electronic tender hosting website, <https://www.tenderlink.com/fea>.

The bid shall contain no alterations, omissions or additions, except those to comply with instructions issued by FEA, or as necessary to correct errors made by the bidder, in which case such corrections shall be initialed by the person or persons signing the bid.

## 2.14 Sealing and Marking of Bids

The bidder shall seal the original copy of the technical proposal and the original copy of the price proposal and each copy of the technical proposal and each copy of the price proposal in separate envelopes clearly marking each one as: "ORIGINAL-TECHNICAL & PRICE PROPOSAL", "COPY NO. 1 - TECHNICAL & PRICE PROPOSAL", etc. as appropriate.

The bidder shall seal the original bids and each copy of the bids in an inner and an outer envelope, duly marking the envelopes as "ORIGINAL", "COPY No. 1", etc.

The inner and outer envelopes shall

- a) be addressed to FEA at the following address:

Tuvitu Delairewa  
General Manager Commercial  
2 Marlow Street, Suva, FIJI.  
Phone: 679 3224 185  
Facsimile: 679 331 1882  
Email: [TuvituD@fea.com.fj](mailto:TuvituD@fea.com.fj)

And

- b) bear the following identification:
  - Bid for: Preferred Supplier for Intelligent Electronic Devices for Power System Protection and Control

- Bid Tender Number: MR 226/2017
- DO NOT OPEN BEFORE: 1600hrs on 18<sup>th</sup> October 2017.

In addition to the identification required, the inner envelope shall indicate the name and address of the bidder to enable the bid to be returned unopened in case it is declared "late" pursuant to Deadline for Submission of Bids.

If the outer envelope is not sealed and marked as above, FEA will assume no responsibility for the misplacement or premature opening of the bid.

## **2.15 Deadline for Submission of Bids**

Bids must be received by FEA at the address specified above no later than 1600 hours (Fiji Time) 18/10/2017.

FEA may, at its discretion, extend the deadline for submission of bids by issuing an addendum, in which case all rights and obligations of FEA and the bidders previously subject to the original deadline will thereafter be subject to the deadlines extended.

## **2.16 Late Bids**

Any bid received by FEA after the deadline for submission of bids prescribed above will be rejected and returned unopened to the bidder.

## **2.17 Modification and Withdrawal of Bids**

The bidder may modify or withdraw its bid after bid submission, provided that written notice of the modification or withdrawal is received by FEA prior to the deadline for submission of bids.

The bidder's modification or withdrawal notice shall be prepared, sealed, marked and delivered in accordance with Sealing and Marking of Bids, with the outer and inner envelopes additionally marked "MODIFICATION" or "WITHDRAWAL", as appropriate. A withdrawal notice may also be sent by fax but must be followed by a signed confirmation copy.

No bid may be modified by the bidder after the deadline for submission of bids.

## **2.18 Rejection of One or All Bids**

FEA reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders of the grounds for the rejection.

## **2.19 Process to be Confidential**

Information relating to the examination, clarification, evaluation and comparison of bids and recommendations for the award of a contract shall not be disclosed to bidders or any other persons not officially concerned with such process. Any effort by a bidder to influence FEA's processing of bids or award decisions may result in the rejection of the bidder's bid.

## **2.20 Clarification of Bids**

To assist in the examination, evaluation and comparison of bids, FEA may, at its discretion, ask any bidder for clarification of its bid. The request for clarification and the response shall be in writing or by fax, but no change in the price or substance of the bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by FEA in the evaluation of the bids.

### 3 GENERAL CONDITIONS OF CONTRACT

The General Conditions of Contract shall be based upon AS 4912 – 2002 General Conditions of Contract for Periodic Supply of Goods.

The Conditions of Contract comprises two parts:

1. Part 1 – General Conditions; and
2. Part 2 – Conditions of Particular Application

### 4 CONDITIONS OF PARTICULAR APPLICATION

#### 1. Interpretation and Construction of Contract

Add the following:

*“Bid has the same meaning as tender.”*

Replace

*“Base contract sum means the sum of the products ascertained by multiplying the quantities of goods stated in Item 13 by the corresponding unit prices, excluding any additions or deductions which may be required to be made under the Contract.”*

With

*“Contract sum means:*

- (a) Where the Purchaser accepted a lump sum, the lump sum;*
  - (b) Where the Purchaser accepted unit prices, the sum of the products ascertained by multiplying the quantities of goods and the corresponding unit prices in the schedule of unit prices; or*
  - (c) Where the Purchaser accepted a lump sum and unit prices, the aggregate of the sums referred to in paragraphs (a) and (b),*
- Excluding any additions or deductions which may be required to be made under the Contract.”*

#### 7. Assignment

Replace “7. Assignment” with “7. Assignment and Subcontracting”

Add “7.1 Assignment” after “7. Assignment and Subcontracting”

Add the following after paragraph 7.1 Assignment.

*“7.2 Subcontracting*

*The Supplier shall not subcontract any part of the Contract without the prior written approval of the Purchaser, which approval shall not be unreasonably withheld. Any sub subcontracting shall not relieve the Supplier from any liability or obligation under the Contract. The Supplier shall if requested by the Purchaser provide copies of the proposed subcontract documents without prices.”*

#### 9. Warranties

Replace “9. Designated Items” and its contents with the following

## **“9. Warranties**

### **9.1 Ownership**

*The Supplier represents and warrants that:*

- a) *It is the legal and beneficial owner of the goods; and*
- b) *that upon payment of the contract sum no person other than the Purchaser will be entitled to hold any interests in, or hold any encumbrance over, the goods.*

### **9.2 Supplier’s Warranty**

*The Supplier represents and warrants that the goods will upon delivery:*

- a) *comply in all respects with the Contract;*
- b) *be suitable for the purpose stated in Item 5;*
- c) *be of merchantable quality;*
- d) *conform to any sample provided by the Supplier and approved by the Purchaser.*
- e) *in the absence of any specific provision of the Contract, meet any relevant Australian Standard and industry best practice;*
- f) *be free of design defects;*
- g) *be, unless otherwise agreed, new.*

*If the Supplier is in breach of any of the warranties in this clause 9, the Purchaser may, in addition to the Purchaser’s other rights and remedies, at any time give 7 days’ written notice to the Supplier to rectify such breach, and if the Supplier fails to comply with such notice, the Purchaser may employ others to carry out works required to satisfy the warranty. The cost thereby incurred shall be moneys due and payable to the Purchaser.*

*The representation and warranties in this clause survive the completion or earlier termination of the Contract and each warranty in this clause is independent of, and is not limited by, reference to any other warranty.*

*The Supplier shall obtain all warranties relevant to the goods from manufacturer or suppliers or as otherwise specified in the Contract, including any warranties that are provided by any sub-contract and ensure that the Purchaser has the benefit of those warranties. “*

## **19. Delivery**

Add the following to 19.1 Date and Place for Delivery, at the end,

*“The Supplier must ensure that all goods are properly, safely and securely packaged and labeled for identification and safety as follows:*

- a) *the goods must be individually packaged for transport so that they are protected from all reasonably foreseeable condition which might cause corrosion, deterioration or physical or bearing damage during handlings and transport. All packaging and preservation materials must be supplied by the Supplier; and*
- b) *each package must be clearly and indelibly inscribed with the Purchaser’s name, the address of the delivery place, the Purchaser’s contract number and any safety warnings for the contents.”*

## **24. Payment**

*Under 24.1 Invoices and Time for Payment, make the following change.*

Replace

*“Within 14 days after receiving an invoice under this Sub-clause, the Purchaser shall pay to the Supplier the amount then due to the Supplier pursuant to the Contract.”*

With

*“Within 30 days after receiving an invoice under this Sub-clause, the Purchaser shall pay to the Supplier the amount then due to the Supplier pursuant to the Contract.”*

## **28. Dispute Resolution**

Replace “28.2 Conference” and contents with the following:

### **“28.2 Conference**

*Within 14 days after receiving a notice of dispute, the parties shall confer at least once to resolve the dispute or to agree on methods of doing so, including, but not limited to, mediation, conciliation, binding expert determination and arbitration, of the whole of any part of the dispute. Where arbitration is agreed method of resolution, the arbitration shall be conducted in accordance with the rules of Item 38(b) and the arbitrator, unless otherwise agreed, shall be nominated by the President of the Fiji Institute of Engineers.*

*At every such conference, each part shall be represented by a person having authority to agree to such resolution or methods. All aspects of every such conference except the fact of occurrence shall be privileged.*

*If the dispute has not been resolved nor a method of resolution agreed within 56 days of service of the notice of dispute, that dispute shall be dealt with in accordance with subclause 28.3.”*

Replace “28.3 Arbitration” and contents with the following

### **“28.3 Elevation of Disputes**

*If the parties are unable to resolve the dispute or agree a method of resolution in accordance with sub clause 28.2:*

- a) the dispute shall be referred to the Chief Executive Officer, or a duly authorized representative, of the Purchaser and the Chief Executive Officer/Managing Director, or a duly authorized representative, of the Supplier to resolve the dispute or agree on a method of resolution;*
- b) the individuals referred to in sub clause 28.3 (a) shall meet within 14 days after referral of the dispute in an effort to resolve the dispute or agree a method of resolution;*
- c) if the individuals referred to in sub clause 28.3 (b) are unable to resolve the dispute but agree at that meeting on a method of resolution, they shall also nominate a timeframe for the commencement and conclusion of the method of resolution; and*
- d) if the individuals so referred to in sub clause 28.3(b) are unable to resolve the dispute or agree a method of resolution, each within 14 days of the dispute being referred, either parts may give written notice to the other stating that the parties have been unable to resolve the dispute or agree a method of resolution.*

*Where arbitration is the agreed method of resolution, the arbitration shall be conducted in accordance with the Rules stated in Item 38(b) and the arbitrator, unless otherwise agreed, shall be nominated by the **President of the Fiji Institute of Engineers.**”*

Replace “28.4 Summary Relief” and the contents with the following:

**“28.4 Instituting Proceedings**

*Neither party shall proceed to resolve a dispute by instituting court proceedings until issuing to, or receiving from, the other party, a notice in accordance with sub clause 28.3(d).”*

Add the following after 28.4 Institutional Proceedings

**“28.5 Summary Relief**

*Nothing herein shall prejudice the right of a party to institute proceedings to enforce payment due under the Contract or to seek injunctive or urgent declaratory relief.”*

**Annexure A**

Replace Annexure Part A with the following:

Item		
1	Purchaser (Clause 1)	Fiji Electricity Authority
2	Purchaser’s Address	2 Marlow Street, Suva
3	Supplier (clause 1)	Supplier to provide
4	Supplier’s Address	Supplier to provide
5	Stated purposes (clause 1 definition of acceptable)	As stated in tender specifications and/or purchase order
6	a) Jurisdiction (legislative requirements)	Fiji
	b) Governing Law	Laws of Fiji
7	a) Currency (clause 1(g))	Supplier to state
	b) Place for payments (clause 1 (g))	Same as Item 2
	c) Place of Business of bank (clause 1(c)- definition of security)	
8	Term (clause 1)	3 years
9	The Goods clause 1	As stated in tender specifications
10	Minimum <i>purchase</i> order quantity subclause 2.2 (a)(i)	1
11	Minimum reorder intervals subclause 2.2 (a)(i)	Not applicable
12	Maximum <i>purchase</i> order quantity subclause 2.2 (b)(ii)	Supplier to state
13	Minimum quantity to be ordered during term subclause 2.2 (a)(iii)	Not applicable
14	Maximum quantity to be ordered during term subclause 2.2 (b)(iii)	Not applicable
15	Supply lead time subclause 2.3(c)	Supplier to provide
17	Supplier’s security	Not Applicable
18	Purchaser’s security	Not Applicable
19	Purchaser – Supplied documents (subclause 6.2)	As stated in tender specifications
20	Supplier- supplied documents (subclause 6.3)	As stated in tender specifications
21	Time for Purchaser’s direction about	14 days

	documents (sub clause 6.3 (b))	
22	Legislative requirements, those expected (subclause 10.1)	Not applicable
23	Reference date (subclause 10.2 (b))	Date of closing of Tender
24	Time by which the insurance cover of goods is to be effected (subclause 13.1)	Time at which order is placed
25	Public and product liability insurance (subclause 13.2)	Supplier to provide
26	Qualifying causes of delay, causes of delay for which EOTs will not be granted	Not applicable
27	Liquidated damages, rate (subclause 17.5)	Not applicable
28	Delay Damages	Not applicable
29	Date for completion of acceptance testing (subclause 18.1 and 21.1)	As stated in tender specification
30	Party responsible for unloading the <i>goods</i> (subclause 19.1)	Supplier
31	a) When risk in the <i>goods</i> passes (subclause 20.1)	At time of acceptance by Purchaser.
	b) Time at which ownership of the <i>goods</i> passes to the Purchaser (subclause 20.2)	Upon payment of the purchase order value
32	Period for <i>Purchaser's</i> notice that <i>goods</i> are rejected (subclause 21.1)	14 calendar days
33	Period for <i>Purchaser's</i> notice accepting or rejecting <i>Supplier's</i> proposal (subclause 21.4)	14 calendar days
34	Defects liability period (clause 22)	24 months
35	Invoice (subclause 24.1) Time for Invoice	Within 30 days of delivery
36	Interest rate on overdue payments (subclause 24.3)	Nil.
37	Supplier's default (subclause 25.2 (c))	28 days
38	Arbitration (subclause 28.3) • Person to nominate an arbitrator	President of Fiji Institute of Engineers
	• Rules for arbitration	Laws of Fiji
39	The Supplier's liability is limited as follows (clause 29)	Purchase order value
40	The Purchaser's liability is limited as follows (clause 29)	Purchase order value

## 5 REFERENCES

### 5.1 Applicable Standards

The IEDs shall be designed, manufactured and tested in accordance with the following engineering standards and their respective amendments issued prior to the date of closing of tenders except where varied by this Specification.

IEC 60068	Environmental Testing (All parts)
IEC 60255-1:2009	Measuring relays and protection equipment - Part 1: Common requirements
IEC 60255-12:1980	Electrical relays - Part 12: Directional relays and power relays with two input energizing quantities
IEC 60255-13:1980	Electrical relays - Part 13: Biased (percentage) differential relays
IEC 60255-21-1:1988	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section One: Vibration tests (sinusoidal)
IEC 60255-21-2:1988	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section Two: Shock and bump tests
IEC 60255-21-3:1993	Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section 3: Seismic tests
IEC 60255-24:2013	Measuring relays and protection equipment - Part 24: Common format for transient data exchange (COMTRADE) for power systems
IEC 60255-26:2013	Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements
IEC 60255-27:2013	Measuring relays and protection equipment - Part 27: Product safety requirements
IEC 60255-121:2014	Measuring relays and protection equipment - Part 121: Functional requirements for distance protection
IEC 60255-127:2010	Measuring relays and protection equipment - Part 127: Functional requirements for over/under voltage protection
IEC 60255-149:2013	Measuring relays and protection equipment - Part 149: Functional requirements for thermal electrical relays
IEC 60255-151:2009	Measuring relays and protection equipment - Part 151: Functional requirements for over/under current protection
IEC 60721-3-3	Classification of groups of environmental parameters and their severities – stationary use at weather protected locations
IEC 60834-1:1999	Teleprotection equipment of power systems - Performance and testing - Part 1: Command systems
IEC 60870	Telecontrol equipment and systems – All parts
IEC 61000-4	Electromagnetic compatibility (EMC) - All parts
IEC 61850	Communication networks and systems for power utility automation – All Parts
IEC 62439-3	Industrial communication networks - High availability automation networks - Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)
IEEE C37.90-1989	IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.1-2012	IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.2-2004	IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

IEEE C37.90.3	IEEE Standard Electrostatic Discharge Tests for Protective Relays
IEEE C37.94	IEEE Standard for N times 64 kbps Optical Fiber Interfaces between Teleprotection and Multiplexer Equipment
IEEE C37.111	IEEE/IEC Measuring relays and protection equipment – Part 24: Common format for transient data exchange (COMTRADE) for power systems
IEEE C37.118	IEEE Standard for Synchrophasors for Power Systems
ISO 9001	Quality Systems Model for Quality Assurance in Design, Development, Production, Installation and Servicing

Should inconsistencies be defined between Standards and this Specification, this Specification will take precedence. However, significant inconsistencies shall be referred to FEA for resolution.

## 5.2 Applicable Laws

The Bidder warrants (without limiting any other warranties or conditions implied by law) that all Goods have been produced, sold and delivered to FEA in compliance with all applicable laws (including all workplace health and safety and electrical safety legislations and codes of conduct).

## 6 GENERAL REQUIREMENTS

### 6.1 Service Conditions

The IEDs shall be suitable for installation in stand-alone cabinets or in low-voltage compartments of high-voltage indoor switchgear, in substation and power station buildings. The typical service conditions are as follows:

Height above sea level	:	not exceeding 1000 m
Atmosphere	:	Saliferous, corrosive and dusty
Ambient temperature	:	Peak : 40°C
	:	24 Hour Average: 30°C
	:	Annual Average: 22°C
	:	Minimum: 10°C
Relative Humidity (Average)	:	90%
Annual Average Rainfall	:	1900 mm
Wind Speed	:	Sustained : 55 m/s
	:	Gusts : 70 – 110 m/s
Isokeraunic Level	:	60 Thunder days per year
Seismic	:	To a maximum of 7 on the open-ended Richter Scale

**Note:** All plant and equipment shall be rust proof, vermin proof and weather proof and designed to be suitable for a damp, tropical climate, which may be experienced simultaneously.

All ferrous parts shall be treated to provide acceptable surface finish and protection. The manufacturer shall provide full details of the surface finish provided.

The equipment shall include everything necessary or usually supplied for the operation, whether directly specified or not.

The insulation level shall be in accordance with the technical requirements stated. All insulation shall be of a type and quality that will give normal life expectancy without deterioration.

## **7 DESIGN AND PERFORMANCE CRITERIA**

### **7.1 General**

The IEDs shall be designed in accordance with standard industry practice and comply with all aspects of these specifications.

The IEDs shall be free of a requirement for planned maintenance. They shall include self-monitoring.

The IED shall be designed to operate over a wide temperature range, from -10deg C to 70 deg C, in tropical climate with high humidity. The IEDs shall not employ any method of forced cooling.

The IED may be installed in a polluted environment; therefore, the internal electronic components shall have protective coating to prevent premature failure of components, or malfunctioning in such harsh operating conditions.

The IEDs will typically be installed either on 11kV or 33kV switchgear low-voltage compartment or in 19U racks, in substations and switching stations.

The IEDs shall not weigh any more than 20kg. Bidders shall provide the required technical particulars for each IED offered.

It is FEA's intention to limit the number of different types of IEDs used. To this end, Tenderers are encouraged to supply IEDs from a limited number of their product families, and to standardize on specific IED types and model numbers within each family, with as few IED hardware and software variations as possible.

### **7.2 Power Supply and Monitoring**

The IED shall be designed to be operated with a power supply voltage of 110 Volts DC nominal. It shall be designed to be operated a range of 85 Volts to 125 Volts DC.

There shall be provision to monitor the power supply and report the power supply voltage variation either through internal settings or through external relay contacts.

The IEDs power supply shall have a quiescent burden of less than 50W.

### **7.3 Current Transformer Inputs**

FEA uses a system where the current transformer secondary has a 1 Amp nominal. Therefore, the IED AC current input circuit shall be designed to operate with a 1 Amp nominal CT secondary for phase and earth fault. For sensitive earth fault current inputs, a rating of 0.05A shall be required.

In addition to this, the following shall apply:

- Thermal rating of 100 Amp for 1 second
- Wide measurement range, between 0.1 and 20 Amp secondary
- Low burden to the CT circuit, <0.15VA

The Tenderer shall provide details of the hardware and software filtering applied to the IED's current inputs.

The current transformer input terminals shall be designed such to allow connection of round lugs with wires upto 4mm<sup>2</sup> CSA.

## 7.4 Voltage Transformer Inputs

FEA uses a system where the voltage transformer secondary has a 63.5 Volt nominal, phase to neutral, three-phase four wire system. The IED AC voltage input circuit shall be designed to operate with a continuous voltage of 67 Volt, phase to neutral.

In addition to this, the following shall apply:

- It shall have a measurement range of 365 Volt for 10 seconds
- It shall have a low burden to the VT circuit, <0.15VA at 67 V

The supplier shall provide details of the hardware and software filtering applied to the IED's voltage inputs.

The voltage transformer input terminals shall be designed such to allow connection of round lugs with wires upto 2.5mm<sup>2</sup> CSA.

## 7.5 Control Inputs

The control inputs shall be designed to comply with IEC 61810-2:2005 or IEEE C37.90-2005.

The control inputs shall be opto-isolated inputs and shall be operated either by DC or AC. It shall be operated at a nominal voltage of 110Volts and shall have a pickup in the range 80%-120% and a drop-off below 75%.

The control inputs shall have adjustable pickup/dropout timers for input energization/de-energization debounce.

The control inputs shall draw <10mA of current at nominal operating voltage.

Whilst FEA has standard IED configurations, the offered IED shall have the capability for the number of inputs to be increased or decreased depending on FEA's requirements. This shall not require a separate device to be put in.

The control input terminals shall be designed such to allow connection of round lugs with wires upto 2.5mm<sup>2</sup> CSA.

## 7.6 Control Outputs

The control outputs shall be designed to comply with IEEE C37.90-1989. They shall have breaking and cyclic capacity as per IEC 60255.

The control outputs shall have a continuous carrying capacity of 6 Amps, making capacity of 30 Amps, and short time capacity of >50Amps for 1 second.

It shall have a breaking capacity of 0.30 Amps and shall be designed for at least 10,000 operations. It shall have a pickup/dropout time of < ¼ cycle.

The output contacts shall also have MOV protection of an appropriate rating.

Whilst FEA has standard IED configurations, the offered IED shall have the capability for the number of control outputs to be increased or decreased depending on FEA's requirements. This shall not require a separate device to be put in.

The control output terminals shall be designed such to allow connection of round lugs with wires upto 2.5mm<sup>2</sup> CSA.

## **7.7 Earthing**

There shall be provision to earth/ground the chassis/frame of the IED to a common/station earth. Such earthing/grounding connection shall be clearly labeled.

## **7.8 Communications**

The IED shall have sufficient communications interfaces to allow local and remote connection.

There shall be a serial or USB port on the front of the IED to allow connection to be established using a portable computer to access the IED.

There shall be sufficient serial, Ethernet and fiber optic ports to allow for data exchange from the IED.

The IED shall also have a number of communications protocols to allow for data to be extracted or written to the IED. It shall have DNP 3.0, IEC 61850, Modbus and ASCII. It shall also allow for telnet, FTP and SNTP connections to be established from one of the communication ports.

FEA may require synchrophasor data from the IEDs and therefore the IED shall have provision for synchrophasor data to be stored and sent to a synchrophasor data collector.

## **7.9 Time Synchronizing**

The IED shall have an internal clock which can be programmed/set from either its driving software or the operator screen. The internal clock shall be powered from an internal battery which shall have a life expectancy of >10years in case the power supply to the IED is lost.

In addition to this, the IED shall have provision to be supplied a modulated or demodulated IRIG-B signal over either a Ethernet network or through a BNC connector. There shall be provision in the IED to select the source or prioritization of the IRIG-B signal.

## **7.10 Operator Screen**

The IEDs shall be equipped with an on-board backlit display/operator screen. The display shall be designed to function correctly over the full operational life of the IED.

The display/operator screen shall allow the following:

- Viewing or modifying protection relay settings
- Viewing disturbance records or events records
- Modifying software controlled switches
- In some cases, display the bay configuration in a diagrammatic format
- Viewing fundamental and selected metering data

- Viewing relay status, such as the status of various critical internal components or converters

The operator screen shall be provided on the front face of the IED. It shall be water proof and have a surface which can be easily cleaned if dust accumulates on it.

The operator screen visibility and operation shall not be impaired over the specified operating temperature range.

### **7.11 Programmable Operator Controls**

FEA may require programmable operator controls, through pushbuttons mounted on the front face of the IED (front being the same face as that with an operator screen) for certain applications. The IED shall have provision for the installation of such programmable operator controls where it is required.

Labeling of the operator controls shall also be possible.

### **7.12 Metering, Event Reporting and Special Reports**

The metering records in the IED shall meet the highest accuracy levels. Current readings at fundamental frequency shall not have an error >0.5% in their recordings. Voltage readings at fundamental frequency shall not have an error >1% in their recordings.

The IED shall have the capability to record power system events and store them in its non-volatile memory. The event recording capability shall include:

- Recording of date and time of event with 1 msec resolution
- Summary of event, including status of any front panel indicators on the IED and fault location where applicable
- Individual sample of analog input with oscillography, at 4, 16, 32 or 128 samples per cycle
- Measured frequency at time of event
- Status of selected digital elements at 4 samples per cycle (Bidder shall provide this list)
- Settings that were active at the time of the event
- Programmable trigger conditions

The duration of the event report in the IED shall be adjustable, with a minimum duration of 15 cycles and maximum duration of 150 cycles.

Recordings shall be made available in COMTRADE format, as per IEC 60255-24.

The event reports shall be viewable in software supplied at no cost to FEA, by the Bidder.

The IED shall also produce special reports, for metering and recording purposes. Such special reports shall include harmonic metering, peak demand metering, load profile recording and current/voltage logging at fundamental frequency.

Selected IEDs shall be required to provide synchrophasor data in accordance with the IEEE C37.118 standard.

### **7.13 Frequency and Phase Rotation**

The IEDs shall be required to operate at a nominal frequency of 50Hz. However, they shall be capable to operate and track frequency in the range 40Hz to 60Hz.

Selected IEDs will be required to track the rate at which the measured frequency is changing. The IEDs shall respond within 3 cycles to track the change in frequency. The IED shall be capable of tracking frequency changes in the range 0.1Hz/sec – 20Hz/sec.

### **7.14 Processing Capabilities and Storage**

The IED shall be capable of sampling upto 128 samples per cycle for current and voltage inputs.

Processing at a rate of four (4) times per power system cycle, or faster, is required.

The IED shall have sufficient storage in non-volatile memory to store significant number of event data, metering data and other special data that may be of interest.

### **7.15 Self-Monitoring**

The IEDs shall have a provision to self-monitor and report failures over designated communications ports, through front operator screen or through output contacts. In case of output contacts, voltage-free contacts shall be provided which shall dis-engage upon generation of an alarm or loss of supply to the IED.

### **7.16 Software Package**

The Bidder shall supply driving software for accessing the IED.

Any cost of licensing shall be borne by the Bidder and shall be included in the supply of the IED. The driving software shall not be restricted in any way and shall allow FEA to fully utilize the IED. This shall include programming and testing the IED, carrying out diagnostic tests and troubleshooting to find cause of any failures.

Driving software for analysis of event files or special reports shall also be provided. The basic software for analysis of such files shall not be restricted in any way that will prevent FEA from analyzing the IED operations.

The Bidder is required to provide any special cables or connections with the IED that will be used to connect to the IED for programming and testing purposes.

There shall be a means to keep track of changes in the firmware if the firmware of a particular IED changes during the contract period. The Bidder shall ensure that any firmware upgrades to already purchased devices are issued at no cost to FEA, with clear instructions to upload the firmware to the IED. Any special tools required to do this shall be provided by the Bidder at their cost, including freight to FEA's nominated delivery place.

The Bidder shall provide a list of all softwares it produces with associated cost in its Bid that may be used in any way with the IEDS, be it for programming, testing, maintenance or recording. This shall not apply to any software or tools produced by others.

### **7.17 Access Controls and Security**

The IED shall have mechanisms for managing electronic and physical access. The IED shall have provision for unused communications ports to be disabled to prevent intrusion.

The IED shall support password setting and management and it shall allow limited functions at each access level. Passwords shall support alphanumeric characters and special characters and could be upto 12 letters long.

There shall be provision in the IED to log any activity in the IED, including changes being made to the configuration or settings. Such logs shall be saved in non-volatile memory.

## **7.18 Protection, Control and Monitoring Functions**

Appendix 1 outlines the protection, control and monitoring functions required from different types of IEDs which may be used in various applications.

## **7.19 Automation and Logic Functions**

The IEDs shall include programmable logic functions for a wide range of user-configurable protection, monitoring, and control schemes. Logic shall have the ability to use protection/control elements, math functions, comparison functions, and Boolean logic functions.

The IED shall include a number of local control switches, remote control switches, latching switches, and programmable display messages in conjunction with a local display panel in the IED. The IED shall be capable of displaying custom messages. Input signals to the IED shall have settable assertion levels.

The Bidders shall provide full details of such IEDs which have automation capabilities.

## **7.20 Design Reviews and Factory Inspections**

The Bidder shall make allowance for one FEA Engineer to visit the factory where the IEDs are manufactured to hold meetings on design, manufacture and testing of the IEDs. The FEA Engineer will be required to carry out factory inspections and review designs where necessary. Such factory inspections shall be carried out once a calendar year for the period of contract.

## 8 TESTING

### 8.1 Testing Obligations

All equipment offered shall be fully type tested at the time of tendering and type test certificates shall be included with the tender regardless of whether such equipment has previously been supplied to FEA. Where equipment is offered of a similar design to that previously tested, consideration may be given to accepting previous type test reports.

Bidders shall state if such tests exist. Bidders may be requested (during the tender evaluation period) to substantiate their claims with written engineering evaluation. Such evaluation shall provide all relevant details so that FEA can establish the validity of existing type tests.

If there are any differences between the plant tested and that offered, the Bidder shall state clearly all the differences and shall include in his tender the particulars of identification detailed in relevant IEEE and IEC Standards.

### 8.2 Type Tests

The offered IEDs shall be subjected to the following type tests.

Category	Type of Test	Requirement
Electromagnetic Compatibility Emissions	Emissions	IEC 60255-22-6:2001
		IEC 61000-4-6:2008
Electromagnetic Compatibility Immunity	Conducted RF Immunity	IEC 60255-22-6:2001 IEC 61000-4-6:2008
	Digital Radio Telephone RF Immunity	ENV 50204:1995
	Electrostatic Discharge Immunity:	IEC 60255-22-2:2008 IEC 61000-4-2:2008 IEEE C37.90.3-2001
	Fast Transient/Burst Immunity	IEC 60255-22-4:2008 IEC 61000-4-4:2004
	Power Supply Immunity	IEC 60255-11:2008 IEC 61000-4-11:2004 IEC 61000-4-29:2000
	Radiated Radio Frequency Immunity	IEC 60255-22-3:2007 IEC 61000-4-3:2008 IEEE C37.90.2-2004
	Surge Withstand Capability Immunity	IEC 60255-22-1:2007 IEEE C37.90.1-2002
Environmental	Cold	IEC 60068-2-1:2007
	Damp Heat, Cyclic	IEC 60068-2-30:2005
	Dry Heat	IEC 60068-2-2:2007
	Vibration	IEC 60255-21-1:1988 IEC 60255-21-2:1988
Safety	Dielectric	IEC 60255-5:2000 IEEE C37.90-2005
		IEC 60255-5:2000 IEEE C37.90:2005
	IP Code	IEC 60529:2001 + CRDG:2003
	Product Safety	C22.2 No. 14 - 95 UL 508

### **8.3 Routine Tests**

The Bidder shall provide a list of routine tests that will be carried out on the IEDs. This shall include:

- Check of relay hardware and internal components
- Communications port tests
- Equipment calibration tests
- Functional checks

Samples of any Inspection and Test Plans used for routine tests shall be submitted with the Bid.

### **8.4 Witnessing of Tests**

The Bidder shall make allowance for one FEA Engineer to carry out inspection of the manufacturing and testing environment once a year, the first straight after contract award, and to witness selected type tests and routine tests which shall be requested to be performed. All costs for the witnessing of such type tests shall be borne by the Bidder.

Where applicable, the Bidder shall give FEA not less than four (4) weeks' notice of when each and every type test will be carried out.

### **8.5 Test Certificates**

An electronic copy and one printed copy of all test reports are to be provided to FEA. Type test reports shall be submitted once only, or whenever they are repeated.

## **9 RELIABILITY**

### **9.1 Service Life**

Bidders are required to comment on the reliability of the equipment and the performance of the materials offered for a service life of 35 years under the specified system and environmental conditions.

### **9.2 Spare Parts and Maintenance**

The Supplier shall supply a list of recommended spare parts, special tools and appliances required for the whole of life operation and maintenance of the IED installation. The list, together with prices, shall be indicated in the appropriate schedule. The Supplier must also provide details (if required) of the recommended maintenance and the frequency at which it must be carried out. Details of the manufacturers repair capability and options shall be provided

### **9.3 Evidence in Support of Reliability**

The Supplier shall indicate and provide updates to FEA the mean time between failures (MTBF) of the IEDs and its components including the recommended maintenance regime and maintenance tasks and intervals. This regime shall be based on the mean time between failure (MTBF) and the critical failure modes identified by the failure mode, effects and criticality analysis (FMECA) of the equipment. Details substantiating the FMECA analysis shall be included in the offer.

Such comments will include evidence in support of the reliability and performance claimed including information on Failure Mode and Effect Analysis.

## **10 ENVIRONMENTAL CONSIDERATIONS**

Bidders are required to comment on the environmental soundness of the design and material used in the manufacture of the items offered. In particular, comments should address such issues as recyclability and disposal at end of service life.

FEA will require, after the evaluation and award of the Tender, to visit the Supplier's factory for compliance checks on various Environmental protection practices in the design, manufacturing, testing and supply of IEDs. The Bidder shall make allowance for such visits, at their cost.

The supplier must provide with the offer, full details, including composition and toxicological information, regarding the health and safety aspects of all the materials offered in their offer or supplied equipment regardless of content.

Recommended procedures must be provided for the safe handling, safe operation and maintenance of products supplied. The means of disposal of the materials must be clearly stated.

Material safety data sheets (MSDS) must be provided for materials that are supplied and subject to safety considerations in handling and use.

All equipment, packaging and all other accessories provided shall be asbestos free.

The above information is required as part of the offer and will be reviewed as part of the tender process.

## **11 PACKAGING AND MARKING**

The packaging of items by the Bidder must ensure that they are capable of being delivered undamaged giving due consideration to the quantity, distance of transportation and the preferred method of handling at each location.

The Bidder shall take all necessary precautions to ensure safe handling of all IEDs and associated accessories supplied.

## **12 QUALITY REQUIREMENTS**

### **12.1 Quality System**

Bidders are required to submit evidence that the design, manufacture and testing of the IEDs are in accordance with ISO 9001.

Documentary evidence shall be provided concerning the level of Quality System Certification associated with the supplier and or manufacturer. This documentation shall include the Capability Statement associated with the Quality System Certification.

FEA will require, after the evaluation and award of the Tender, to visit the Supplier's factory for compliance checks on various quality management practices in the design, manufacturing, testing and supply of IEDs.

## **13 STOCK AVAILABILITY**

The Bidder is to advise if there will be any consignment stock-holding.

## **14 PRODUCT WARRANTY PERIOD**

The Bidder is required to provide a minimum warranty period of ten (10) years from time of dispatch from factory shall be provided.

## **15 INFORMATION TO BE SUPPLIED BY THE BIDDER**

### **15.1 Documentation to be Supplied with the Tender**

To enable FEA to fully evaluate the IED(s) offered, the Bidder will submit the following information with their tender:

- Dimensioned general arrangement drawings of IEDs, in metric units
- A schedule of drawings with all drawings provided
- Description of the principle of operation.
- Typical schematic diagrams for all items.
- Type test certificates for all equipment offered.
- List of tools and spares for maintenance and operation
- Typical installation and maintenance manuals
- End of service life disposal method
- Instruction, installation, operating and maintenance manuals.
- Evidence of quality management systems used in manufacture, testing and supply
- Evidence of Health, Safety and Environmental plans
- Evidence of financial ability to provide the level of service and support
- Origin of materials used in manufacture of the IEDs
- Detailed procedure for receiving, handling, lifting and storage
- Names and resumes of key team members who will be assigned to work with FEA upon successful award of the three-year supply contract (if Bidder is successful).
- A list of all departures of the tender from this Technical Specification
- Any other documentation as recommended by the Bidder.

Where sub-contractors are used, the Bidder shall provide the above information for the sub-contractors as well. Bidders may be asked to provide additional information during tender assessment period or following award of contract.

All information shall be provided in the English language.

The Bidder must exercise reasonable diligence in the design of items in order to satisfy FEA's specific integration requirements between the Bidder's offered item and FEA's requirement for the item to be utilized.

### **15.2 Samples**

Samples of typical units may be required during the tender assessment period. Sample will be required only from Bidders who have previously not supplied IEDs to FEA.

When samples are required, production samples shall be delivered freight free, suitably packaged and labeled including reference to the Tender Number and purchase order number.

FEA may at its discretion either purchase the samples at the tendered price or return the samples to the respective Bidder after the contract has been awarded.

### **15.3 Training**

Training material in the form of drawings, instructions and/or audio visuals shall be provided for all the items offered and accepted by FEA. This material shall include but is not limited to the following topics:

- Handling
- Storage
- Installation
- Programming, testing, troubleshooting and fault finding
- Maintenance program
- Environmental performance
- Electrical performance
- disposal

## **Tender Submission - Instruction to bidders**

It is mandatory for Bidders to upload a copy of their bid in the TENDER LINK Electronic Tender Box no later than 4:00pm, on Wednesday 18<sup>th</sup> October 2017

To register your interest and tender a response, view 'Current Tenders' at: <https://www.tenderlink.com/fea>

For further information contact The Secretary Tender Committee, by e-mail [TDelairewa@fea.com.fj](mailto:TDelairewa@fea.com.fj)

In addition, hard copies of the tender, one original and one copy must be deposited in the tender box located at the FEA Head Office, 2 Marlow Street, Suva, Fiji no later than 4:00pm, on Wednesday 18<sup>th</sup> October 2017 - Addressed as

Tender – MR 226/2017 Preferred Supplier for Intelligent Electronic Devices for Power System  
Protection and Control  
The Secretary Tender Committee  
Fiji Electricity Authority  
Head Office  
Suva  
Fiji

- Ø Hard copies of the Tender bid will also be accepted after the closing date and time provided a soft copy is uploaded in the e-Tender Box and it is dispatched before the closing date and time.

Tenders received after 4:00pm on the closing date of Wednesday 18<sup>th</sup> October, 2017

- Ø will not be considered.
- Ø Lowest bid will not necessarily be accepted as successful bid
- Ø It is the responsibility of the bidder to pay courier charges and all other cost associated with the delivery of the hard copy of the Tender submission including any Duties/Taxes. Hard copies of the Tender submission via Post Box will not be considered.
- Ø Local Bidders are requested to submit a:
  - **Valid Tax Compliance Certificate**
  - **FNPF Compliance Certificate**

## APPENDIX 1: REQUIRED PROTECTION, CONTROL AND MONITORING FUNCTIONS

The offered IEDs shall be used for various functions. Listed below are the key protection, control and monitoring functions required in IEDs for various applications. FEA expects that more than one model/type of IED may be required depending on the application type.

IED Application	Required Protection, Control and Monitoring Functions
Distribution Feeder Protection, Sub-transmission Line Protection	<ul style="list-style-type: none"> <li>• Multiple level, Phase, negative sequence, residual and neutral overcurrent protection elements with user programmable pickup, time-multiplier or time delay settings, IEC operating curves</li> <li>• Directionality with all overcurrent elements, where direction can be selected by the user</li> <li>• Six levels of under and over-frequency protection elements</li> <li>• Voltage Elements – the IED shall incorporate phase and phase-to-phase under- and overvoltage elements as well as sequence overvoltage elements for protection and control.</li> <li>• Rate of change of frequency elements</li> <li>• Circuit breaker failure detection function</li> <li>• Communications assisted tripping schemes</li> <li>• Four levels of power elements with user programmable direction and level settings</li> <li>• Second harmonic blocking element</li> <li>• Auto-Reclosing Control - The IED shall incorporate a four-shot recloser with four independently set open time intervals. Independently set reset times from reclose cycle and from lockout shall be available. User programmable timers, latch bits, display functions and counters</li> <li>• High-impedance fault detection</li> </ul>
Two-winding or Three-Winding Transformer Protection	<ul style="list-style-type: none"> <li>• Transformer Differential Protection – the IED shall include a single, three-phase low-impedance current differential element with adaptive restraint/operate slope characteristics.</li> <li>• Negative-Sequence Differential Protection - the IED shall include negative-sequence differential protection for turn-to-turn fault detection within the transformer. The negative-sequence differential element shall detect turn-to-turn faults as low as two percent of the total winding.</li> <li>• Transformer Inrush and Overexcitation Detection – the IED shall incorporate 2nd, 4th, and 5th harmonic blocking. In addition, 2nd and 4th harmonic restraint shall be provided. These restraint and blocking elements may be used independently, or in combination to prevent restrained differential element operation during inrush or overexcitation conditions. An independent fifth-harmonic element shall be included to warn of transformer overexcitation conditions. Wave-shape-based inrush detection addresses inrush conditions that contain low 2nd and 4th harmonic content.</li> <li>• Unrestrained Differential Protection – the IED shall include unrestrained differential protection to provide rapid tripping for internal faults.</li> <li>• External Faults - the IED shall detect an external fault and enter into a high-security mode.</li> <li>• CT Phase Angle Compensation – the IED shall incorporate full “round-the-clock” current compensation, in 30-degree increments, to accommodate virtually any type of transformer and CT winding connection.</li> <li>• Combined Currents. The IED shall incorporate elements to provide overcurrent protection based on summation of currents from combinations of the ST, TU, UW, and WX transformer winding inputs to the IED.</li> </ul>

	<ul style="list-style-type: none"> <li>• Restricted Earth Fault Protection. The IED shall provide three separate restricted earth fault (REF) protection elements for the detection of ground faults in wye-connected windings.</li> <li>• Breaker Failure Protection – the IED shall include internal breaker failure protection with retrip functions for each of the terminals, and be selectable to also accept external breaker failure protection.</li> <li>• Overcurrent Protection - the IED shall include phase, negative-, and zero-sequence overcurrent for both instantaneous and time-overcurrent elements. Torque control capability shall be provided for the inverse-time overcurrent elements. Adaptive time-overcurrent elements shall be provided that allow operate quantity selection and programmable time-delay and pickup settings.</li> <li>• Current Unbalance – the IED shall provide current unbalance elements for detecting phase current unbalance as compared to the average phase current.</li> <li>• Voltage Elements – the IED shall include three-phase over- and undervoltage elements as well as negative- and zero-sequence overvoltage elements.</li> <li>• Synchronism Check – the IED shall include a synchronism-check element. The synchronism-check function shall incorporate slip frequency, maximum angle difference, breaker close time, and allows different sources of synchronizing voltage.</li> <li>• Volts/Hertz Elements – the IED shall provide a single V/Hz element with two separate characteristic curves for protection during loaded and unloaded transformer operation.</li> <li>• Frequency Elements – the IED shall include two levels of over- and underfrequency settings for each set of three-phase voltage inputs (six elements total). The frequency elements shall maintain pickup accuracy from 40.0 to 70.0 Hz.</li> <li>• Frequency Tracking – the IED shall provide frequency tracking from 40.0 to 65.0 Hz when voltage inputs are provided to the IED.</li> <li>• External Devices – the IED shall not need external devices. All configuration and logic shall be realized in the IED software.</li> </ul>
Two-terminal or three-terminal line protection	<ul style="list-style-type: none"> <li>• Current Differential Protection – the IED shall compare local and remote phase and sequence currents to provide operation in less than one cycle and it shall also operate for unbalanced faults with currents below line charging current. The IED shall have provision to be unaffected by CT saturation either at local or remote end(s). Differential protection shall be disabled via programmable logic condition to accommodate switching operations without requiring settings change or settings group change.</li> <li>• Distance Protection - the IED shall incorporate at least four zones of phase and ground mho distance and quadrilateral ground distance protection for use if potentials are available. Two zones shall be settable for either forward or reverse direction. Both positive-sequence memory polarized and compensator-distance phase distance elements shall be available. The IED shall detect CCVT transients and block the operation of underreaching Zone 1 distance elements during the transient period. In some instances, sub-cycle tripping will be required, to 1ms.</li> <li>• Power swing detection and blocking - the IED shall detect stable and unstable power swings.</li> <li>• Load encroachment logic</li> <li>• Communications assisted tripping schemes</li> <li>• Tapped Load Coordination - the IED shall selectively coordinate with inverse-time overcurrent protection on a tapped load using total current from all line terminals.</li> <li>• Synchronism Check – the IED(s) shall include two synchronism-check elements with separate maximum angle settings. The synchronism-check function shall incorporate slip frequency and close angle settings and allow different sources of synchronizing voltage</li> </ul>

	<ul style="list-style-type: none"> <li>• Multiple level, Phase, negative sequence, residual and neutral overcurrent protection elements with user programmable pickup, time-multiplier or time delay settings, IEC operating curves</li> <li>• Six levels of under and over-frequency protection elements</li> <li>• Voltage Elements. The relay shall incorporate phase and phase-to-phase under- and overvoltage elements as well as sequence overvoltage elements for protection and control.</li> <li>• Rate of change of frequency elements</li> <li>• Circuit breaker failure detection function</li> <li>• Communications assisted tripping schemes</li> <li>• Four levels of power elements with user programmable direction and level settings</li> <li>• Second harmonic blocking element</li> <li>• Auto-Reclosing Control - The IED shall incorporate a four-shot recloser with four independently set open time intervals. Independently set reset times from reclose cycle and from lockout shall be available. User programmable timers, latch bits, display functions and counters</li> </ul>
Synchronous Generator Protection	<ul style="list-style-type: none"> <li>• Two-zone, positive-sequence impedance mho element for loss-of-field detection</li> <li>• 100% stator ground fault detection based on measurement of neutral overvoltage plus neutral and terminal third-harmonic voltage differential with settable sensitivity</li> <li>• DC field ground protection (64F) based on switched dc voltage injection method</li> <li>• Out-of-step protection based on single or double blinders</li> <li>• Overexcitation detection based on volts/hertz measurement</li> <li>• Negative-sequence overcurrent elements, including definite-time and inverse-time operating characteristics</li> <li>• Sensitive directional power elements with flexibility to provide antimotoring, over-power, or low-forward power indication</li> <li>• Two-zone compensator distance and voltage-restrained or voltage-controlled phase time-overcurrent element for backup protection</li> <li>• Phase, residual, neutral, and negative-sequence instantaneous and definite-time overcurrent; and inverse-time residual and neutral overcurrent elements</li> <li>• Restricted earth fault (REF) protection element for the detection of ground faults in wye-connected windings.</li> <li>• Directional residual-ground overcurrent elements</li> <li>• Directional neutral overcurrent elements</li> <li>• Phase, phase-to-phase, positive-sequence, negative-sequence, and residual overvoltage elements, phase, phase-to-phase, and positive-sequence undervoltage elements, and synchronism-check voltage input over- and undervoltage elements.</li> <li>• Inadvertent energization protection</li> <li>• Unit breaker failure protection</li> <li>• Supervision of voltage-based protection functions by loss-of-relaying-potential detection logic</li> <li>• Over- and underfrequency elements and rate-of-change-of-frequency elements</li> <li>• Percentage restraint and unrestrained phase current differential elements with fixed or variable percentage, using one or two settable slopes. Second-, fourth-, and fifth-harmonic elements, with the choice of either harmonic blocking or harmonic restraint to prevent restrained differential element operation during inrush or overexcitation conditions.</li> <li>• Ground differential element</li> <li>• Full "round-the-clock" current compensation, in 30-degree increments, to accommodate virtually any type of transformer/generator and CT winding</li> </ul>

	<p>connection.</p> <ul style="list-style-type: none"> <li>• Synchronism-check element and autosynchronizer with speed control and voltage control outputs.</li> <li>• Thermal model element for overload protection and RTD-based thermal protection.</li> </ul>
Busbar Protection (High-Impedance)	<ul style="list-style-type: none"> <li>• High-Impedance Differential Protection - the IED shall have three independent differential elements, each with two setting levels to provide for protection as well as open CT detection. The IED shall include MOVs with the ability to clamp the peak voltage below 2000 V.</li> <li>• Overcurrent Protection - the IED shall incorporate overcurrent elements to provide phase, negative-sequence, and residual current protection.</li> </ul>
Busbar Protection (Low-impedance)	<ul style="list-style-type: none"> <li>• Differential Protection - the IED shall include six low-impedance current differential elements.</li> <li>• Directional Element - The IED shall include phase-comparator directional elements for each zone.</li> <li>• Check Zone - the IED shall include a single, dedicated check zone with its own adaptive differential element and settings.</li> <li>• Current Transformer Inputs - the IED shall accept CTs from different classes and a ratio mismatch of 10:1. Measuring quantities shall be on a phase-segregated basis and not from summation CTs.</li> <li>• Current Transformer Alarm - The IED shall include an element in each zone to detect CT open or short circuit conditions.</li> <li>• Breaker Failure Protection - the IED shall include internal breaker failure protection with retrip functions for each of the terminals, but be selectable to also accept external breaker failure protection.</li> <li>• Overcurrent Protection – the IED shall include both instantaneous and time-overcurrent elements for each of the 18 current inputs. Torque control capability shall be provided for the inverse-time overcurrent elements.</li> <li>• Voltage Elements - the IED shall include three phase over- and undervoltage elements as well as negative- and zero-sequence overvoltage elements.</li> <li>• End-Zone Protection – the IED shall include the capability to provide protection for a fault between the open circuit breaker and the CT.</li> <li>• External Faults – the IED shall detect an external fault and enter into a high-security mode but not block the differential protection at any time.</li> <li>• Dynamic Busbar Replica – the IED shall, without external devices, use the disconnect contacts to create a replica of the busbar linking in order to assign the terminal currents to the correct differential elements.</li> <li>• Disconnect Monitor - the IED shall include logic to monitor the open/close operations of up to 48 disconnects (isolators) and provide individual alarms for each disconnect.</li> </ul>
Capacitor Bank Protection	<ul style="list-style-type: none"> <li>• Voltage Differential Protection - the IED shall provide three phase-voltage differential protection with null compensation. The voltage differential protection shall provide three levels of settings for alarm, trip, and catastrophic failure conditions.</li> <li>• Neutral-Voltage Differential Protection – the IED shall provide neutral-voltage differential protection with null compensation. The neutral-voltage differential element shall calculate zero-sequence voltage from three phase-voltage inputs to the IED, and measure differential voltage with respect to a neutral-voltage input. The neutral-voltage differential protection shall provide three levels of settings for alarm, trip, and catastrophic failure conditions.</li> <li>• Phase-Current Unbalance Protection – the IED shall provide phase-current unbalance protection with null compensation. The phase-current unbalance protection shall be capable of detecting as little as 20 mA of current unbalance on a 1 A CT secondary input. The phase-current unbalance protection shall provide three levels of settings for alarm, trip, and catastrophic failure conditions.</li> </ul>

	<ul style="list-style-type: none"> <li>• Neutral-Current Unbalance Protection – the IED shall provide neutral-current unbalance protection with null compensation. The neutral-current unbalance protection shall be capable of detecting as little as 20 mA of current unbalance on a 1 A CT secondary input. The phase-current unbalance protection shall provide three levels of settings for alarm, trip, and catastrophic failure conditions.</li> <li>• Instantaneous and Time Overcurrent Fault Protection – the IED shall provide overcurrent elements for phase, negative-sequence, and zero-sequence currents.</li> <li>• Voltage Protection Elements - the IED shall provide six overvoltage and six undervoltage elements with two level settings per element. Level 1 settings shall have definite-time delay capabilities. Input voltages to the elements shall be selectable from phase, zero-sequence, positive-sequence, negative-sequence, and maximum quantities. RMS and fundamental voltages shall be supported.</li> <li>• Frequency Protection Elements – the IED shall have six independent frequency elements with definite-time delay. The frequency elements shall have undervoltage supervision inputs.</li> <li>• Breaker Failure Elements – the IED shall have breaker failure protection with flashover detection. Breaker failure protection shall operate using subsidence detection logic to minimize coordination time requirements of downstream devices.</li> <li>• Automatic Control – the IED shall be capable of providing independent dead-band controllers. Each control shall be capable of either voltage, power factor, or VAR control.</li> </ul>
Arc flash detection	<ul style="list-style-type: none"> <li>• Arc-flash detection and arc-flash overcurrent – this function may reside in one of multi-function IEDs above or in a dedicated device. Fiber optic sensors and fiber optic cables shall be used for sensing in this scheme.</li> </ul>

