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เงื่อนไขเฉพาะงาน : กลาง งานจ้างเหมาปรับปรุงประสิทธิภาพระบบควบคุมและป้องกันสถานีไฟฟ้า ระยะที่ 1 ตามงบประมาณลงทุนประจำปี 2565

<table>
<tr><th>Clause No.</th><th>Clause Name</th><th>Conformance Status (C,A or N)</th><th>Standard Equipment Status (S or M)</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td>1</td><td>7.3ผู้รับจ้างจะต้องส่งมอบระบบ SCPS ที่มีรายละเอียดสอดคล้องกับความต้องการของ กฟภ. ตาม Specification No. RSUB-010/2564 (Rev. 1.0) และที่ระบุไว้ใน ADDENDUM ของ Specification No. RSUB-010/2564 (Rev.1.0) รวมทั้งการเชื่อมต่อระบบ SCPS กับระบบ SCADA ของ กฟภ. ให้ทำงานร่วมกันได้อย่างสมบูรณ์ ข้อความใดๆ ใน Specification No. RSUB-010/2564 (Rev. 1.0) และใน ADDENDUM ของ Specification No. RSUB-010/2564 (Rev.1.0) หากมีข้อความใดที่ขัดหรือแย้งกับเงื่อนไขประกวดราคาเพิ่มเติมฉบับนี้ ให้ใช้ข้อความที่ระบุไว้ในเงื่อนไขประกวดราคาเพิ่มเติมฉบับนี้แทน และรวมถึงภาคผนวกต่างๆ ด้วย และงานจะถือว่าเสร็จสิ้นไม่ได้หาก กฟภ. ยังไม่ได้ตรวจรับและรับมอบงานงวดสุดท้าย โดยมีส่วนที่จะต้องแก้ไขข้อกำหนดใน Specification No. RSUB-010/2564 (Rev. 1.0) และใน ADDENDUM ของ Specification No. RSUB-010/2564 (Rev.1.0) ดังนี้
1)ตาม Specification No. RSUB-010/2564 (Rev. 1.0) Clause 4.1 GENERAL REQUIREMENTS , replace the first paragraph (in Page 31 of 403) by the following:
“A warranty period shall be at least 5 years long for Relay, and at least 2 years long for SCPS.”</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>2)ตาม ADDENDUM ของ Specification No. RSUB-010/2564 (Rev.1.0) ข้อ (2) Clause 4.2.2 Bay Level, replace the typical of Protection relay function (in Page 1 of 3) by the following:
“Typical of Protective relay functions can be categorized as:
1) 115 kV Bus Protection (Main 1 and Main 2) 87B, 95B
2) 115 kV Line Protection (Main 1 and Main 2) 21/21N, 67/67N, 25, 27/59, 79, 50BF
3) 115 kV Transformer Protection (Main 1 and Main 2) 87T,87REF, 50/51, 50N/51N, 51GB, 50BF
4) Others 115 kV Protections
5) 22 or 33 kV Feeder Protection 50/51, 50N/51N, 67/67N, 25, 79, 50BF, 81, 27/59
6) Others MV Protections
All protection functions of the protective relay shall be completely programmed from manufacturer’s factory.”</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>(5)ผู้รับจ้างต้องออกแบบและติดตั้งระบบ SCPS ซึ่งมีคุณสมบัติเป็นไปตามข้อกำหนดดังนี้ (ตาม ADDENDUM ของ Specification No. RSUB-010/2564 (Rev.1.0))
<table><tr><th>คุณสมบัติ</th><th>ข้อกำหนด</th></tr><tr><td>Network redundancy protocol</td><td>Parallel Redundancy Protocol (PRP)
and/or High Availability Seamless Redundancy (HSR)</td></tr><tr><td>Time synchronization</td><td>IEEE 1588 or IRIG-B</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>(6)สำหรับ Ethernet Switch ที่จะนำมาใช้ในระบบ SCPS จะต้องมีคุณสมบัติเป็นไปตามข้อกำหนดดังนี้ (ตาม ADDENDUM ของ Specification No. RSUB-010/2564 (Rev.1.0))
<table><tr><th>คุณสมบัติ</th><th>ข้อกำหนด</th></tr><tr><td>Conform to the industrial environment performance</td><td>According to IEEE 1613– class 1 for the Ethernet Switch used in station bus level</td></tr><tr><td>OSI Model Support</td><td>Ethernet Switch at a station bus level shall be L3 type</td></tr><tr><td>Auxiliary Supply</td><td>1) 125 VDC nominal voltage (substation DC system) with minimum range 80-120% of nominal voltage, or
2) 230 VAC nominal voltage with ±10% of nominal voltage</td></tr><tr><td>Network Switch and Time Synchronization</td><td>Transparent Clock</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>(7)รายละเอียดอุปกรณ์ในระดับ Station Level สำหรับ Network Topology 1 ให้ออกแบบ จัดหาและติดตั้งอุปกรณ์ ดังนี้
1)อุปกรณ์Time Data Server (TDS) ของระบบ SCPS จะต้องมีอุปกรณ์ GPS Receivers และ GPS Antenna จำนวนอย่างละ 2 ชุด โดยทั้ง 2 ชุด จะต้องทำงานพร้อมกันตลอดเวลาและสามารถทำงานได้ครบถ้วนตาม Spec No. RSUB-010/2564 (Rev. 1.0) ข้อ 7.7 Station Time Synchronization โดยจะต้องมี TDS ทั้ง 2 ชุด ที่สามารถพร้อมทดแทนกันได้ทันทีในกรณีที่อุปกรณ์ TDS ตัวใดตัวหนึ่งมีเหตุให้ไม่สามารถใช้งานได้</td><td></td><td></td><td></td><td></td></tr>
</table>

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5	(9)ผู้รับจ้างต้องออกแบบและติดตั้งอุปกรณ์ Engineering Workstation (EWS) และ Network Management System (NMS) ทั้ง Hardware และ Software สำหรับทุกสถานีไฟฟ้า โดย Hardware (จะต้องมีพอร์ต) และ Software จะต้องมีความสามารถรองรับการเชื่อมต่อในรูปแบบ Remote access configuration ผ่านระบบ Network ด้วยอุปกรณ์ที่ติดตั้งใช้งานเฉพาะที่สำนักงานใหญ่ ของ กฟภ.				
6 (Protection Management System)	(10)ผู้รับจ้างต้องออกแบบและติดตั้งระบบ Protection Management System (PMS) ทั้ง Hardware และ Software สำหรับทุกสถานีไฟฟ้า โดยอุปกรณ์ Hardware (จะต้องมีพอร์ต) และ Software จะต้องมีความสามารถรองรับการเชื่อมต่อกับอุปกรณ์ Protection Management System (PMS) Server ที่จะติดตั้งใช้งานที่สำนักงานใหญ่ ของ กฟภ. (ซึ่ง กฟภ. มีแผนที่จะติดตั้งใช้งานที่สำนักงานใหญ่ ในอนาคต) ซึ่งระบบจะต้องความสามารถพื้นฐานอย่างน้อยดังต่อไปนี้ 1)Remote configuration All Relay directly in PEA Substation 2)View device settings and manage change history 3)View and automatic download retrieved fault records, events, and Oscillography All Relay in PEA Substation 4)Store all data in the database 5)Provide web interface to view and download events 6)View reports on screen 7)Print and export reports 8)Securing remote access 9)One user account to access all applications and devices 10)Define access permissions per user, per group, per device				
7 (Digital Fault Recorder)	(11)ผู้รับจ้างจะต้องจัดหาพร้อมติดตั้งอุปกรณ์ Digital Fault Recorder (DFR) สำหรับสถานีไฟฟ้ากระนวน สถานีไฟฟ้าหนองเรือ สถานีไฟฟ้าโพนพิสัย สถานีไฟฟ้าศรีสงคราม สถานีไฟฟ้าคลองหลวง สถานีไฟฟ้าดอนพุด สถานีไฟฟ้าปทุมธานี 3 สถานีไฟฟ้ามาบข่า สถานีไฟฟ้าชลบุรี 3 สถานีไฟฟ้าจอมบึง สถานีไฟฟ้าชะอำ 2 โดยมีรายละเอียดคุณสมบัติ ดังนี้ 1)อุปกรณ์ Digital Fault Recorder ต้องมีคุณสมบัติทางเทคนิคและฟังก์ชั่นการทำงานตามที่ระบุไว้ใน Annex 10 – Digital Fault Recorder (DFR) Specification ของสเปคเลขที่ RSUB-010/2564 (Rev. 1.0) 2)อุปกรณ์ Digital Fault Recorder จะต้องประกอบด้วย Hardware (จะต้องมีพอร์ตสื่อสาร) โดยจะต้องติดตั้งเครื่อง DFR Server (ที่สถานีไฟฟ้า) สำหรับจัดการ DFR และรวบรวมข้อมูลไฟล์ต่าง ๆ ที่ได้จากการทำงานของ DFR เช่น Comtrade File โดย DFR Server (ที่สถานีไฟฟ้า) จะต้องสามารถดึงข้อมูลจาก DFR ได้โดยอัตโนมัติ (ตามเหตุการณ์ที่เกิดขึ้น หรือตามรอบเวลา) ซึ่ง DFR Server (ที่สถานีไฟฟ้า) ดังกล่าวต้องใช้ระบบปฏิบัติการ Windows เท่านั้น ซึ่งต้องเป็นเวอร์ชั่น Windows 10 หรือใหม่กว่า และต้องสามารถติดตั้ง Software ที่มีความสามารถรองรับการเชื่อมต่อและใช้งานร่วมกับ Data Server for Digital Fault Recorder (DFR) (ซึ่ง กฟภ. มีแผนที่จะติดตั้งใช้งานที่สำนักงานใหญ่ ในอนาคต) ได้ โดยระบบจะต้องมีความสามารถพื้นฐานดังต่อไปนี้ - Remote configuration - View device settings and manage change history - View and download retrieved fault records - Shall automatically dial and transmit data to Master station at PEA's headquarters				
7 (Digital Fault Recorder)	3)อุปกรณ์ Digital Fault Recorder ที่จะเสนอสำหรับติดตั้งใช้งาน จะต้องสามารถทำงานได้ครบถ้วนถูกต้องตามข้อกำหนด โดยให้ติดตั้ง Software ของ DFR ของระบบ ที่อุปกรณ์ DFR Server (ที่สถานีไฟฟ้า) เท่านั้น ไม่อนุญาตให้นำ Software ของ DFR ไปติดตั้งที่คอมพิวเตอร์ชุดอื่นๆ ของระบบ SCPS 4) อุปกรณ์ Digital Fault Recorder จะต้องจัดเก็บข้อมูลเรคคอร์ดต่าง ๆ ที่บันทึกได้ตามเงื่อนไขของการบันทึกข้อมูลของอุปกรณ์ โดยจะต้องจัดเก็บอยู่ในรูปแบบ COMTRADE files ตามมาตรฐาน IEEE C37.111 – 1999 หรือ edition ที่ใหม่กว่า				

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<table>
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(Digital Fault Recorder)</td><td>5) อุปกรณ์ Digital Fault Recorder ต้องมีรูปแบบการนำสัญญาณเข้าดังนี้
<table><tr><td colspan="2">1. ระดับแรงดัน 115 kV</td></tr><tr><td colspan="2">1.1 Analog Input</td></tr><tr><td>PT Bus</td><td>นำเข้าทั้ง 3 เฟส ทุก Bus</td></tr><tr><td>PT Line</td><td>นำเข้าทั้ง 3 เฟส ทุกเบย์ (กรณีมีไม่ครบ 3 เฟส ให้นำเข้าเฉพาะเฟสที่ใช้สำหรับ Sync.)</td></tr><tr><td>CT Line</td><td>นำเข้าทั้ง 3 เฟส ทุกเบย์</td></tr><tr><td>CT coupling Bus</td><td>นำเข้าทั้ง 3 เฟส</td></tr><tr><td>CT High Side Transformer</td><td>นำเข้าทั้ง 3 เฟส ทุกเบย์</td></tr><tr><td>CT Low Side Transformer</td><td>นำเข้าทั้ง 3 เฟส ทุกเบย์</td></tr><tr><td>CT Neutral Transformer</td><td>(ถ้ามี)</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7
(Digital Fault Recorder)</td><td>5) อุปกรณ์ Digital Fault Recorder ต้องมีรูปแบบการนำสัญญาณเข้าดังนี้
<table><tr><td colspan="2">1.2 Digital Input</td></tr><tr><td>Circuit Breaker</td><td>- Status (52a,52b) ของทุก Circuit Breaker</td></tr><tr><td>Disconnecting Switch</td><td>- Status ของทุก Disconnecting Switch</td></tr><tr><td>Bus Protection</td><td>- Bus Differential Relay Trip
- Bus Differential Lockout Operated (86B)
- Breaker Fail Lockout Operated (86BF)
- 87B On/Off Status
- 50BF On/Off Status</td></tr><tr><td>Line Protection</td><td>- Distance Relay Trip
- Directional Overcurrent Relay Trip
- Time Delay (CB Fail) Trip
- Auto Reclose Operated
- Tele Communication Fail (ถ้ามี)
- 21Tele On/Off Status
- 67Tele On/Off Status
- 50BF On/Off Status</td></tr><tr><td>Transformer Protection</td><td>- Transformer Differential Relay Trip
- Restrict Earth Fault Relay Trip
- Overcurrent Relay Trip
- Earth Fault Relay Trip
- Power Transformer Internal Protection Trip
- Time Delay (CB Fail) Trip
- Transformer Lockout Operated (86T1)
- Transformer Lockout Operated (86T2)
- 87T On/Off Status
- 87REF On/Off Status
- 50BF On/Off Status</td></tr><tr><td colspan="2">2. ระดับแรงดัน 22 kV/33kV</td></tr><tr><td colspan="2">2.1 Analog Input</td></tr><tr><td>PT Bus</td><td>นำเข้าทั้ง 3 เฟส ทุก Bus</td></tr><tr><td>CT Line</td><td>นำเข้าทั้ง 3 เฟส เฉพาะ Incoming</td></tr><tr><td colspan="2">2.2 Digital Input</td></tr><tr><td>Circuit Breaker</td><td>- Contact (52a, 52b) ของ Incoming</td></tr><tr><td>Incoming Protection</td><td>- Over Current Relay Trip
- Over Current Earth Fault Relay Trip
- Time Delay (CB Fail) Trip</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8
(Cyber Security Management System)</td><td>(12)ผู้รับจ้างจะต้องออกแบบ จัดหาและติดตั้ง ระบบการรักษาความมั่นคงปลอดภัยไซเบอร์ (Cyber Security) โดยมีรายละเอียด ดังนี้
(12.1)ระบบการรักษาความมั่นคงปลอดภัยไซเบอร์ (Cyber Security)จะต้องสามารถดำเนินการร่วมกับระบบเทคโนโลยีสารสนเทศ รวมทั้งสอดคล้องกับนโยบายและแนวปฏิบัติความมั่นคงปลอดภัยสำหรับสารสนเทศของ กฟภ. (PEA Cyber Security) โดยการดำเนินการให้เป็นไปตามANNEX 7 – Cyber Securities Requirements ของสเปคเลขที่ RSUB-010/2564 (Rev. 1.0) ทั้งนี้ กฟภ.ขอสงวนสิทธิ์ในการตรวจสอบและปรับปรุงระบบ Cyber Security ดังกล่าว ที่ผู้รับจ้างออกแบบมา โดยผู้รับจ้างต้องรับผิดชอบค่าใช้จ่ายในการปรับปรุงระบบ (ถ้ามี)
(12.2)ผู้รับจ้างจะต้องออกแบบ จัดหาและติดตั้งระบบการรักษาความมั่นคงปลอดภัยไซเบอร์ (Cyber Security) จะต้องประกอบด้วย Hardware และ Software โดยจะต้องออกแบบการป้องกัน (Security perimeters) ให้สอดคล้องกับแนวทางการเชื่อมต่อเครือข่ายตามรูปที่ 2</td><td></td><td></td><td></td><td></td></tr>
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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
8 (Cyber Security Management System)	(12.3)ระบบ SCPS จะต้องมีความสามารถพื้นฐานในการรักษาความมั่นคงปลอดภัยไซเบอร์ (Cyber Security) อย่างน้อยดังต่อไปนี้ 1)Next-Gen Firewall that detects ICS protocols 2)IDS/IPS 3)Strong remote access authentication (รองรับ Multi-Factor Authentication) 4)Security perimeters 5)Role-based access control 6)User authentication 7)Password management 8)Security event monitoring 9)System performance monitoring 10)Patch management 11)Configuration management 12)System hardening 13)Unused ports/drives/services disabled 14)Backup and recovery 15)Anti-virus (12.4)การติดตั้งอุปกรณ์ Firewall และการแบ่ง Zone การของอุปกรณ์ที่มีการเชื่อมต่อกับเครือข่ายภายนอก ได้แก่ CGW, EWS, PMS และ DFR นั้น จะเป็นลักษณะการต่อ 2 พอร์ท โดยใช้ 1 พอร์ทเชื่อมต่อกับเครือข่าย Station bus ของระบบ SCPS และ 1 พอร์ท เชื่อมต่อกับเครือข่ายของ กฟภ. โดยจะต้องเชื่อมต่อผ่านอุปกรณ์ Firewall เท่านั้น				
9	(16)สำหรับ 115 kV Line Protection, 115 kV Transformer Protection และ 115 kV Bus Protection จะต้องเป็นแบบ Double Main Protection ทั้งนี้อุปกรณ์ทั้ง Main 1 และ Main 2 จะต้องต่างผลิตภัณฑ์กัน				
10	(17)อุปกรณ์ 22 kV หรือ 33 kV Protection Relayand Bay Control Unit ต้องเป็นอุปกรณ์ตัวเดียวกันในทุกเบย์ และจะต้องมีฟังก์ชั่นดังนี้ -22 kV/33kV Feeder Management : -50/51, 50N/51N, 67/67N, 25, 79, 50BF, 81, และ 27/59				
11	(18)ผู้รับจ้างต้องจัดหาอุปกรณ์และออกแบบฟังก์ชั่น Simultaneous Fault สำหรับระบบ 22 kV และ 33 kV ให้ครบถ้วนตามที่ กฟภ. กำหนดโดยให้ใช้สัญญาณ GOOSE ตามมาตรฐาน IEC 61850 ในการแลกเปลี่ยนข้อมูลระหว่างอุปกรณ์ เพื่อใช้ในการสร้างลอจิกของฟังก์ชันดังกล่าว พร้อมทั้งติดตั้ง Cut-Off Switch (Enable/Disable) ที่ตู้ Incoming บัสละ 1 ตัว				
12	(19)ในส่วนของ 22 kV Capacitor ต้องดำเนินการติดตั้งอุปกรณ์จำนวน 2 ชุด (ตามที่ระบุในตารางรายการแจ้งปริมาณงาน (Bill of Materials) ของแต่ละสถานีไฟฟ้า) ดังนี้ 1)ออกแบบและติดตั้งอุปกรณ์ Protection Relay and Bay Control Unit จำนวน 1 Set ที่ฝาตู้ _CVB-01 และ 2)ออกแบบและติดตั้งอุปกรณ์ Bay Control Unit (BCU) จำนวน 1 Set ต่อ Capacitor Bank 1 ชุดภายในห้อง Capacitor Bank				

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<table>
<tr><th>Clause No.</th><th>Clause Name</th><th>Conformance Status (C,A or N)</th><th>Standard Equipment Status (S or M)</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td>13</td><td>(20)ผู้รับจ้างต้องออกแบบให้มีการติดตั้งอุปกรณ์ Lockout Relay สำหรับ 115 kV Bus Protection, 115 kV Transformer Protection Main 1 และ 115 kV Transformer Protection Main 2 โดยให้ผู้รับจ้างเลือกใช้เป็นผลิตภัณฑ์ที่ กฟภ. เคยใช้งานและได้รับความเห็นชอบจาก กฟภ. โดยมีรายละเอียดดังนี้
(20.1) 86B Lockout Relay (86B+ 86BF) (อย่างน้อย 20 Contact และเพียงพอต่อติดตั้งใช้งานตามจำนวนวงจรจริงของสถานีไฟฟ้า) ต่อ 1 บัส เพื่อทำหน้าที่ Trip และ Block Close สำหรับ 115 kV Busbar Protection (สำหรับสถานีไฟฟ้าที่มีเป็นรูปแบบ 115 kV Bus Scheme ที่มี Bus Protection จำนวน 1 โซน เช่น Main and Transfer Bus Scheme)
(20.2) 86B Lockout Relay (86B+ 86BF) (อย่างน้อย 10 Contact และเพียงพอต่อการใช้งานภายในแต่ละเบย์ (115 kV Line Bay, 115 kV Transformer Bay) เพื่อทำหน้าที่ Trip และ Block Close สำหรับ 115 kV Busbar Protection (สำหรับสถานีไฟฟ้าที่มีเป็นรูปแบบ 115 kV Bus Scheme ที่มี Bus Protection แยกเป็นหลายโซน เช่น Double Bus Single Breaker Bus Scheme)
(20.3) Lockout Relay (อย่างน้อย 20 Contact และเพียงพอต่อติดตั้งใช้งานตามจำนวนวงจรจริงของสถานีไฟฟ้า) ต่อ 1 วงจร (Main 1 และ Main 2) เพื่อทำหน้าที่ Trip และ Block Close สำหรับ 115 kV Transformer Protection</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>(21)ฟังก์ชั่น 50BF สำหรับระบบ 22 kV หรือ 33 kV จะต้องออกแบบให้ใช้อุปกรณ์ Lockout Relay (อย่างน้อย 20 Contact และเพียงพอต่อติดตั้งใช้งานตามจำนวนวงจรจริงของสถานีไฟฟ้า) ต่อ 1 บัส เพื่อทำหน้าที่ Trip ผ่านทาง Hardwire ไปยัง Feeder อื่นๆ โดยให้ผู้รับจ้างเลือกใช้เป็นผลิตภัณฑ์ที่ กฟภ. เคยใช้งานและได้รับความเห็นชอบจาก กฟภ.
ทั้งนี้สำหรับสถานีไฟฟ้าที่มีระบบ 22 kV หรือ 33 kV จำนวน 3 บัส นั้น อุปกรณ์ Lockout Relay ของบัสที่ 2 จะต้องมีอย่างน้อย 30 Contact</td><td></td><td></td><td></td><td></td></tr>
<tr><td>15</td><td>(22)ผู้รับจ้างต้องออกแบบให้มีการติดตั้งอุปกรณ์ Trip Circuit Supervision Relay แยกสำหรับระบบ 115 kV ซึ่งจะต้องครอบคลุมจำนวนวงจรทริปของทุกเบย์ โดยให้ผู้รับจ้างเลือกใช้เป็นผลิตภัณฑ์ที่ กฟภ. เคยใช้งาน และได้รับความเห็นชอบจาก กฟภ.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>16</td><td>(23)ผู้รับจ้างต้องออกแบบให้มีการติดตั้งอุปกรณ์ 27X (Under Voltage Relay) สำหรับ DC Circuits ของทุกเบย์และทุกฟีดเดอร์ในแต่ละวงจรให้ครบถ้วนของทุกวงจรโดยให้เลือกใช้เป็นผลิตภัณฑ์ที่ กฟภ. เคยใช้งาน และได้รับความเห็นชอบจาก กฟภ.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>17</td><td>(24)ผู้รับจ้างต้องออกแบบให้มีการติดตั้งอุปกรณ์ Relay Test Block สำหรับ Protection Circuit โดยมีรายละเอียดดังนี้
<table>
<tr><th>รูปแบบ</th><th>ตำแหน่งที่ติดตั้ง</th><th>Test Block</th><th>สำหรับวงจร</th><th>ชนิด</th></tr>
<tr><td rowspan="4">Topology 1</td><td rowspan="2">115 kV Protection and Control Panel</td><td>No. 1</td><td>AC Circuit, VT และ CT</td><td>Test Block No.1 (Type 02)</td></tr>
<tr><td>No. 2</td><td>DC Circuit, Trip coil 1 & 2</td><td>Test Block No.2 (Type 01)</td></tr>
<tr><td rowspan="2">22 kV Switchgear</td><td>No. 1</td><td>VT และ CT</td><td>Test Block No.1 (Type 02)</td></tr>
<tr><td>No. 2</td><td>DC Circuit</td><td>Test Block No.2 (Type 01)</td></tr>
</table>
Contact ขา 13-14 ได้
(2) Test Block No.2 (Type 01) คือ อุปกรณ์ Test Block สำหรับ DC Circuit โดยจ่าย DC Supply ให้แก่อุปกรณ์ Protect Relay ผ่านขา 13-14 (DC Supply+) และขา 15-16 (DC Supply -) และต้องสามารถตัดวงจร DC Supply ดังกล่าวได้ เมื่อถอดฝาครอบของอุปกรณ์ Test Block โดยการเปิดขา 13 และ 14 ออกจากกัน
(24.1) สำหรับ 115 kV Bus Differential Relay ให้ติดตั้ง Test Block No.1 (Type 02) แยกตามจำนวนเบย์ 115 kV ที่มีตามแต่ละสถานีไฟฟ้า</td><td></td><td></td><td></td><td></td></tr>
</table>

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เงื่อนไขเฉพาะงาน : กลาง งานจ้างเหมาปรับปรุงประสิทธิภาพระบบควบคุมและป้องกันสถานีไฟฟ้า ระยะที่ 1 ตามงบประมาณลงทุนประจำปี 2565

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
18	(25)สำหรับระบบ 115 kV ผู้รับจ้างจะต้องดำเนินการจัดหาติดตั้ง Control Cable และ External Cable สำหรับวงจรต่างๆ ต่อไปนี้ ให้ครบถ้วนตามความต้องการของระบบ SCPS ที่ติดตั้งใหม่ 1)Secondary current transformer circuits 2)Secondary voltage transformer circuit 3)Substation equipment DC or AC Control circuits 4)Status and alarm circuit 5)Power supply circuit				
19 (Inverter)	(28)Inverter ที่จะนำมาติดตั้งใช้งาน จะต้องเป็นไปตามข้อกำหนดดังนี้ (28.1) ขนาดพิกัดInverter ไม่น้อยกว่า 4,000 VA, Output Power ไม่น้อยกว่า 3,200 W สามารถรองรับโหลดของอุปกรณ์ที่ Station Level ได้แก่ อุปกรณ์ Industrial Computer, Monitor, Printer และ Ethernet Switch (กรณีที่รับไฟ AC) เป็นต้น (28.2) เป็นชนิด Tower Type หรือถ้าเป็น Rack Type จะต้องติดตั้งที่ Panel ซึ่งแยกออกจาก Station Panel (28.3) ในการติดตั้งใช้งาน Inverter จะต้องมี Maintenance Bypass Switch รองรับ mode การทำงาน ได้แก่ (1) Normal Mode สำหรับกรณีทำงานในสภาวะปกติ โดยเป็นใช้ไฟ DC ซึ่งรับจาก DC Distribution Board แปลงเป็นไฟ AC เพื่อจ่ายให้โหลด (2) Maintenance Bypass Mode สำหรับกรณีทำงานในสภาวะที่ต้องการสลับไปรับไฟ AC ซึ่งรับจาก AC Distribution Board เพื่อจ่ายให้โหลด				
21	(30)ผู้รับจ้างต้องรับผิดชอบการปรับปรุงวงจรตู้ DC Board และ AC Board ให้สามารถใช้งานได้ครบถ้วนและเพียงพอกับการใช้งานสำหรับอุปกรณ์ SCPS ที่ติดตั้งใหม่ทั้งหมดทุกวงจร รวมถึงกรณีที่จะต้องจัดหาอุปกรณ์เพิ่มเติมด้วย ยกตัวอย่างเช่น MCB, External Cable และ Name Plate เป็นต้น				
22	(31)การตั้งค่าและรูปแบบการทำงานของ GoCB (GOOSE Control Block) ต้องเป็นไปตามที่มาตรฐาน IEC 61850 กำหนด โดยต้องมี MAC Address ของ GoCB อยู่ในช่วงดังต่อไปนี้ และต้องไม่ใช้ Address ซ้ำกัน				
23	(32)ผู้รับจ้างต้องจัดหาอุปกรณ์ระบบควบคุมและป้องกัน รวมถึงอุปกรณ์ที่เกี่ยวข้อง เพื่อใช้ในการออกแบบติดตั้งฟังก์ชันระบบ ATS (Automatic Transfer Switch) สำหรับระบบการจ่ายไฟ 115kV แบบ Loop Line				

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Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
1	Scope The detailed design submissions include: 1) Schematic or Circuit Drawings (Station & Bay Level) – AC and DC distribution, instrument transformer & power circuit, measuring & instrumentation circuit, communication network, switching device tripping & closing circuits, protection circuits, manual synchronizing, alarm monitoring, system drawing, terminal function diagram, etc.				
	The Integrated SCPS shall be designed: 1) To accommodate future substation upgrades, modifications, extension and expansion 2) To achieve the objectives of IEC 61850 standard, i.e. interoperability, simple configuration & allocation of functions, and be future proof 3) To ensure high reliability, performance and availability to minimize the interruption of service and functions 4) To ensure that single failure at station level or one bay will not affect the operation and functions of other bays 5) To maximize the utilization of substation information for supporting decision processes, engineering, operation & maintenance, fault investigation & diagnostics, and asset management 6) To optimize the application of devices, panels, cabling and substation space 7) To provide safe, secure and reliable operation of the substation throughout its total life cycle 8) To withstand harsh operational substation environment such as the impact of electromagnetic interference and adverse environmental conditions.				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	The Contractor shall design and implement the Integrated SCPS to facilitate: 1) A distributed architecture using distributed station and bay intelligent devices, functions and applications 2) full system integration via substation communication network 3) fully automated functions 4) the separation of substation operator interface and engineering interface 5) the station level operator interface and SCADA gateway to perform station/supervisory monitoring and control operation of the substation 6) to support engineering workstations to manage the SCPS, communication network and substation information, and to provide applications utilizing the substation information 7) to support the application of Ethernet Technology and Information Communication Technology (ICT) such as Client-Server communication, Peer-to-Peer communication, web-based application, SCL, MMS (Manufacturer Message Specification), TCP/IP and Ethernet 8) IEC 61850 enabled technology including IEC 61850 conformant multifunction intelligent devices 9) self-monitoring, condition-based monitoring (optional) and management of intelligent devices, communication network and substation equipment. The Contractor shall propose condition-based monitoring as an option, together with a separate quotation, for PEA approval. 10) the integration of intelligent devices in single panel 11) the interoperability of IEDs from several different manufacturers to exchange information and use the information for their own functions. 12) the maximum utilization of information from IEDs.				

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<tr><td>1.2</td><td>OBJECT MODELLING
The Contractor shall perform the following typical tasks as part of the scope to abstractly model the substation data before mapping to mainstream communication protocols:
1) Analyse PEA requirements, substation single line diagram, constraints and functions as specified in the specifications
2) Define the abstract model data and communication services model (i.e., Abstract Communication Service Interface, ACSI) based on the functions, SCADA points and requirements
3) Determine the functions allocation and the Logical Nodes (Refer to IEC 61850-7-4, 61850-7-410, and 61850-7-420 for the complete list of all IEC 61850 Logical Nodes as a reference)
4) Map the required functions to the Logical Node and their data
5) Determine the object modelling including the Logical Device modelling
6) Determine the information flows, and data exchanges within the substation
7) Create PEA SCL files (.icd., and .scd files) for the specific substation configuration based on .ssd file provided by PEA
8) Generate .cid file from .scd file and configured all the IEDs used for the substation
9) Determine the data sets and control blocks of the IEDs based on the above modelling</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.3
1.3.1
1.3.1.1</td><td>ENVIRONMENTAL CONSTRAINTS AND ELECTROMAGNETIC
Environmental Data
All the equipment supplied in the scope of this project shall be compliant with the environment constraints listed in paragraph.
Temperature requirements:
<table>
<tr><th>Category</th><th>I</th><th>II</th><th>III</th></tr>
<tr><td>Rated operation range (1)</td><td>T1: +5°C T2: +40°C</td><td>T1: -10°C T2: +55°C</td><td>T1: -25°C T2: +70°C</td></tr>
<tr><td>Maximum operation limits (2)</td><td>T3: +5°C T4: +40°C</td><td>T3: -10°C T4: +55°C</td><td>T1: -25°C T2: +70°C</td></tr>
<tr><td>Relative humidity At + 23°C</td><td>75 %</td><td>80 %</td><td>90 %</td></tr>
<tr><td>Storage and transport conditions (3)</td><td>-40°C +70°C</td><td>-40°C +70°C</td><td>-40°C +70°C</td></tr>
<tr><td>Operation location example</td><td>Air conditioned room</td><td>Non-air conditioned room</td><td>Outdoor Equipment</td></tr>
</table>
The three above definitions are extracted from IEC 60359.</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>1.3.1.2</td><td>Class of Equipment
According to these figures, the equipment to be supplied shall be compliant with tropical constraints.
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Cold</td><td>IEC60068-2-1</td><td>-</td><td>- 25°C / 96 h (storage)
+ 5°C / 96 h (in operation)</td></tr>
<tr><td>Dry heat</td><td>IEC60068-2-2</td><td>-</td><td>+ 70°C / 96 h (storage)
+ 70°C / 96 h (in operation)</td></tr>
<tr><td>Damp heat</td><td>IEC60068-2-78</td><td>-</td><td>+ 55°C / 95% / 96 h (storage)
+ 40°C / 93% / 96 h (in operation)</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>ELECTROMAGNETIC ENVIRONMENTAL STANDARDS
Isolation tests: voltage withstand
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Rated insulation voltage</td><td>IEC60255-27</td><td>-</td><td>500 VDC</td></tr>
<tr><td>Insulation impedance</td><td>IEC60255-27</td><td>-</td><td>100 MΩ</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>ISOLATION TESTS: DIELECTRIC WITHSTAND
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Rated insulation voltage</td><td>IEC60255-27</td><td>-</td><td>2 kV/50 Hz/1 mn</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Isolation tests: impulse voltage withstand
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Unidirectional surge
1.2 / 50 µs (voltage)
8 / 20 µs (current)</td><td>IEC61000-4-5
IEC60255-27</td><td>-</td><td>5 kV (supply)
5 kV (I/O)
1 kV (communication)</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Immunity tests against radiated electromagnetic field disturbances
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Radiated
electromagnetic field
disturbance</td><td>IEC61000-4-3
IEC60255-26</td><td>3</td><td>30 V/m
(15 V/m for talky-walky frequencies)</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Immunity tests against recurrent fast transient
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Electrical fast transient
burst</td><td>IEC61000-4-4</td><td>4</td><td>4 kV (supply)
4 kV (input/output)
4 kV (communication)</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td>1 MHz damped oscillatory wave tests
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>1 MHz damped oscillatory wave</td><td>IEC60255-26</td><td>3</td><td>2.5 kV CM (supply)
2.5 kV (input/output)
2.5 kV (communication)</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Electrostatic discharge
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Electrostatic discharge</td><td>IEC61000-4-2
IEC60255-26</td><td>4</td><td>15 kV contact</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Mechanical shock
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Semi-sinusoidal shock in operation</td><td>IEC60068-2-27</td><td>-</td><td>15 g / 11 ms
1 shock per sense and per axe</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Fast transient tests for measuring relays with single input
TEST METHOD CLASS SEVERITY
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Fast transient disturbance test</td><td>IEC60255-3</td><td>3</td><td>2.5 kV CM (supply)
2.5 kV (input/output)
2.5 kV (communication)</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Vibrations
<table>
<tr><th>TEST</th><th>METHOD</th><th>CLASS</th><th>SEVERITY</th></tr>
<tr><td>Sinusoidal vibrations (in operation)</td><td>IEC60068-2-6</td><td></td><td>10 to 55 Hz / 0,15 mm or 2 gn
2 hours per axe</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.3.1.3</td><td>Ventilation
The specified equipment shall be able to operate in normal continuous service without forced ventilation under the following environmental conditions. In order to increase the reliability a forced ventilation shall be included. In case of a failure of the forced ventilation equipment, an alarm shall be sent to the substation control unit.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The formation of condensed water on the circuit boards, modules, covering and in general in the apparatus shall be avoided.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>All equipment covered by this specification shall be selected and especially treated, as required, for used in a tropical climate and for protection against fungus growth and corrosion during shipment and storage.</td><td></td><td></td><td></td><td></td></tr>
</table>

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Bid No. : ร่างเอกสารประกวดราคา

Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
1.3.2	Physical Environment and Service Conditions All SCPS equipment shall be housed in dust proof and water proof housing cabinet to IEC 60529, protection class IP50 or better for indoor, and protection class IP65 for outdoor, but shall be adequately ventilated to prevent damage to any component when exposed to high ambient temperatures.				
1.3.2.1	Outdoor Devices All MUs & Smart I/Os (Merging Units and Smart I/Os) plus their power supply modules and supporting LAN plus all necessary connectors, extenders, terminators and LAN assembly devices shall be classed as SCPS outdoor devices. The proposed SCPS outdoor devices shall be suitable for continuous operation in Thailand's tropical monsoon climate and shall also be subject to severe thunderstorms, heavy industrial pollution and high levels of airborne dust. The proposed SCPS outdoor devices shall be conformally coated to meet the specified climatic conditions (Class C2 in accordance with IEC 60870-2-2 and class 3K7 in accordance with IEC 60721), and shall have been type tested for continuous operation over the following environmental conditions:				
	• Temperature : -10°C to +70°C (test with IEC 60068-2-1, 60068-2-2, 60068-2-3 and 60068-2-14) • Temperature Gradient : Up to 30°C (test with IEC 60068-2-1, 60068-2-2, 60068-2-3 and 60068-2-14) • Relative Humidity : Up to 95% at 40°C (test with IEC 60068-2-30 and 60068-2-38) • Cyclic Damp Heat : +40°C to +25°C at 95% Relative Humidity (test with IEC 60068-2-30 and 60068-2-38) • Absolute Humidity : Up to 29 g/m3 (test with IEC 60068-2-30 and 60068-2-38) • Vibration (sinusoidal) : 2 g acceleration 9 to 350 Hz (test with IEC 60068-2-6) • Shock : 15 g 11 ms (test with IEC 60068-2-27) The above referenced type tests shall be carried out by suitably accredited test laboratories, which are independent of the bidder and SCPS manufacturer. The certified copies of test certificates and test results shall be included as part of the bidder's proposal. Failure to conform to this requirement shall be constitute for rejection of the bidder's proposal				

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Bid No. : ร่างเอกสารประกวดราคา

Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
1.3.2.2	Indoor Devices The SCPS Systems, IED relay, BCU, IED device and Local User Interface (HMI) plus their power supplies and all supporting equipment shall be classed as SCPS indoor devices. Indoor devices, in air-conditioned rooms, shall be suitable for continuous operation over the following environmental conditions: • Operating Temperature : between 20 °C and 27 °C. • Relative humidity : between 40% and 60%. Malfunctioning of air conditioning equipment may cause the temperature to increase to 40 °C with humidity up to 95%. Therefore, indoor devices shall be suitable for operation under these conditions for a continuous period of up to 24 hours. So, the same IEC standards as mentioned in the previous chapter (outdoor devices), shall be also the standards for indoor devices.				
1.3.3	Electromagnetic Environmental Precautions The correct operation of the substation control system and protection equipment shall not be limited or restricted by environmental influences. Therefore the substation control system and protection equipment shall be designed to withstand the influence of: 1) Switching operations in primary circuits 2) Lightning stroke in HV line 3) Lightning stroke in grounded component 4) Switching operations in secondary circuits 5) Faults occurring within or near the substation producing ground currents and ground potential rise 6) Radio interferences produced by hand-held walkie-talkie type radio communication equipment (P = 2 Watt) in the frequency range 80/160/460 MHz at 30 cm distance The measures to be taken to reduce EMI (electromagnetic interferences) are listed below:				

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Bid No. : ร่างเอกสารประกวดราคา

Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
1.3.3.1	Primary circuits Most of the measures listed below are necessary to protect HV equipment but they have also a beneficial effect on interference to secondary circuits. 1) Protection against lightning strokes 2) Protection by lightning arrests 3) Configuration of earthing systems 4) Use of VT and CT with acceptable transient response				
1.3.3.2	Secondary circuits In secondary circuits the following measures shall be at least adopted to reduce EMI. 1) Separation of the various circuits connected with devices having different degrees of interference level (power supplies, input and output network circuits, earth connections). 2) Galvanic separation of the I/O signal circuits and of the auxiliary supply circuit lines with isolating relays, optodiodes, transformers, coupling condensers. 3) Screens of the cables from switch bays shall not be laid to adjacent unshielded circuits.				
	Further following measures are to be taken in the installation: 1) Separation (spacing out or different routes) of power circuits (e.g. AC power supply cables) from control cables. 2) Separate cabling of the low frequency and high frequency circuits 3) Earthing connection of equipment shall be kept as short as possible and generally separated from the cables. For HV equipment at least two connections are necessary. 4) Increasing density of the earthing mat meshes where the occurrence of high transient current is more likely (lightning arresters, spark gaps, VT and CT). 5) Impedance between equipment (VT and CT etc.) and the earth network shall be as low as possible. 6) Cable route shall run as far as possible from and not parallel to busbars or power cables. 7) The forward and return conductor of the same circuit shall run in the same cable. 8) Twisted pairs or quad cables shall be adopted whenever possible (i.e. low current circuits and data lines).				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	9) Screened cables shall run as close together as possible. 10) DC auxiliary supply cables shall be laid in a radial configuration better than a ring. 11) Screen of perfectly homogeneous with low resistance, protected of the external high frequency electric and magnetic field for the cables shall be provided. 12) Screen of the cables shall have low coupling impedance within the interference frequency range. 13) Earthing of the screen shall have very low impedance with adequate section minimum length and optimum contact arrangements.				
1.3.4	Immunity to Electrical Stress and Disturbance The electrical and electronic components of the proposed SCPS shall satisfy the requirements for insulation, isolation, and immunity from electromagnetic interference, radiated disturbance and electrostatic discharge stated in the following sub-clauses 1.3.4.1 and 1.3.4.2. The ability to meet these requirements shall be verified by type tests.				
1.3.4.1	Minimum Insulation of Equipment Exposed Equipment: “Exposed” equipment terminals may be interconnected without special protection of the insulation. Equipment terminals shall be considered “Exposed” when they directly connected to: 1) Current or voltage transformer secondary circuits. 2) Substation 125 V DC battery supplies. 3) Conductor longer than 100 meters within the substation. 4) Substation 125 V DC supplies.				
	Controlled Exposure Equipment: “Controlled Exposure” equipment terminals may be interconnected when special conditions are met. Equipment terminals shall be considered “Controlled Exposure” terminals when all of the following criteria are met: 1) The rated voltage of the associated circuit does not exceed 32 V AC or 48 V DC. 2) Direct galvanic connections to exposed equipment terminals are made using a suitable barrier device which has the isolation ratings required for exposed equipment. 3) Terminals are galvanically connected to circuits which less than 100 meters in length and are themselves isolated from other components in a way that meets the requirements of exposed equipment.				

<table>
<tr><th>Clause No.</th><th>Clause Name</th><th>Conformance Status (C,A or N)</th><th>Standard Equipment Status (S or M)</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td></td><td>The SCPS equipment shall meet or exceed the insulation requirements shown in Table 1.1:
Table 1.1 – MINIMUM INSULATION REQUIREMENTS

<table>
<tr><th rowspan="2">Requirements</th><th rowspan="2">Test Standard</th><th colspan="2">Specified Details</th></tr>
<tr><th>Exposed Equipment</th><th>Controlled Exposure Equipment</th></tr>
<tr><td>Rated Insulation Voltage</td><td>IEC 60255-5 Table I</td><td>500 V</td><td>60 V</td></tr>
<tr><td>Dielectric Test Voltage</td><td>IEC 60255-5 Table I Series B (Clause 6)</td><td>2.0 kV r.m.s.</td><td>1.0 kV r.m.s.</td></tr>
<tr><td>Insulation Resistance Test</td><td>IEC 60255-5 (Clause 7)</td><td>Required</td><td>Required</td></tr>
<tr><td>Impulse Voltage Test</td><td>IEC 60255-5 (Clause 8)</td><td>5 kV, 1.2/50 µs 0.5 J</td><td>5 kV, 1.2/50 µs 0.5 J</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.3.4.2</td><td>Immunity from Electromagnetic Interference, Radiated Disturbance and Electrostatic Discharge

The SCPS shall be designed for safe operation in the harsh environment of a high voltage substation and shall conform to the immunity, susceptibility and interference requirements shown in Table 1.2:
Data communication ports shall be demonstrated to withstand disturbance test without permanent corruption of data, and subsequent delay of data transfer.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Table 1.2 – IMMUNITY, SUSCEPTIBILITY AND INTERFERENCE REQUIREMENTS

<table>
<tr><th>Requirements</th><th>Test Standard</th><th>Class or Level</th><th>Specified Details</th></tr>
<tr><td>High Voltage Impulse</td><td>IEC 60060-1</td><td></td><td>5 kV, 0.5 J</td></tr>
<tr><td>Electrical Disturbances
(1 MHz Burst)</td><td>IEC 60255-22-1
IEC 60255-22-1</td><td>Class 3
Class 3</td><td>2.5 kV CM
1.0 kV DM</td></tr>
<tr><td>Electrostatic Discharge
Immunity</td><td>IEC 61000-4-2
IEC 61000-4-2</td><td>Level 3
Level 4</td><td>8 kV air
8 kV direct</td></tr>
<tr><td>Radiated Immunity</td><td>IEC 61000-4-3
IEC 60255-22-3
IEC 61000-4-3
ENV 50204 (GSM)</td><td>Level 3
Class 3
Class 3
Level 3</td><td>80 MHz-1 GHz
27-500 MHz
50 KHz-1 GHz
10V/m 2W at 0.6m</td></tr>
<tr><td>Fast Transient/Burst
Immunity</td><td>IEC 61000-4-4
IEC 60255-22-4
ANSI/IEEE C37.90.1</td><td>Level 4
Class 4
-</td><td>4 kV
4 kV
4-5 kV</td></tr>
<tr><td>Surge Immunity</td><td>IEC 61000-4-5</td><td>Level 4</td><td>2 kV/4 kV</td></tr>
<tr><td>Conducted Immunity</td><td>IEC 61000-4-6</td><td>Level 3</td><td>10 V</td></tr>
<tr><td>Harmonics Emissions</td><td>IEC 61000-4-7</td><td>-</td><td>Required for ac powered systems</td></tr>
<tr><td>Power Frequency Magnetic Field Immunity</td><td>IEC 61000-4-8</td><td>Level 4</td><td>30 A/m</td></tr>
<tr><td>Pulse Magnetic Field Immunity</td><td>IEC 61000-4-9</td><td>Level 5</td><td>1000 A/m</td></tr>
<tr><td>Damped Oscillatory Magnetic Field Immunity</td><td>IEC 61000-4-10</td><td>Level 4</td><td>30 A/m</td></tr>
<tr><td>Oscillatory Transient
Immunity</td><td>IEC 61000-4-12
IEC 61000-4-12
ANSI/IEEE C37.90.1</td><td>Level 4
Level 3
-</td><td>Ring Wave
Damped Oscillatory
2.5 kV</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th>Clause No.</th><th>Clause Name</th><th>Conformance Status (C,A or N)</th><th>Standard Equipment Status (S or M)</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td>4
4.1
4.1.1</td><td>CONTROL AND PROTECTION SYSTEM FUNCTIONAL REQUIREMENTS
GENERAL REQUIREMENTS
System Average Life Time and Life Cycle
3) The Contractor shall state the expectancy support for spare parts. Availability of these parts shall be guaranteed for a period of no less than ten (10) years from the date of the latest delivery of equipment containing these parts or assemblies. The Contractor shall commit to notifying PEA at least six (6) months in advance of any part or assembly becoming unavailable for purchase, in order to enable PEA to stock up on that item.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.1.2</td><td>Substation Environment
The SCPS shall be designed to withstand harsh operational HV substation environment. All IEDs shall be certified by an independent competent entity and type tested as protection grade devices. Unless specified otherwise, all station clients shall be certified and type tested as industrial grade equipment.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The following is the summary of the required electrical technological conformance and mechanical requirements for substation environment considerations:
<table>
<tr><th>System Requirements</th><th>Type of Test</th></tr>
<tr><td rowspan="3">Mechanical Stress (Vibration and shock)</td><td>Vibration Test</td></tr>
<tr><td>Shock and bump test</td></tr>
<tr><td>Seismic Test</td></tr>
<tr><td>Insulation</td><td>High Voltage Test and Impulse Voltage Tests</td></tr>
<tr><td rowspan="8">Electromagnetic Compatibility – Immunity</td><td>Damped oscillatory wave test</td></tr>
<tr><td>Fast transient test</td></tr>
<tr><td>Surge Test</td></tr>
<tr><td>Conducted radio interference test</td></tr>
<tr><td>Electrostatic discharge test</td></tr>
<tr><td>Variations and interruptions in AC and DC auxiliary voltage</td></tr>
<tr><td>Electromagnetic fields</td></tr>
<tr><td>50Hz power frequency magnetic fields</td></tr>
<tr><td rowspan="2">Electromagnetic Compatibility – Noise Emission</td><td>Conducted RF interference on power supply terminals and radiated interference. Harmonics for AC supply</td></tr>
<tr><td>Flicker</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.1.3</td><td>System Performance
The SCPS shall be designed such that system performance, including system availability and system reliability set forth in Clause 4.3 is satisfied.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.1.4</td><td>Operation and Maintenance (Maintainability)
The SCPS shall be designed such that system maintainability, including future extension and upgrade, system flexibility, system scalability, and substation access control and cyber security measure, which are described further in Chapter 11, is satisfied.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.1.5</td><td>Operational and System Safety
The SCPS shall be designed so that it is compliant with PEA safety rules and other safety standards, such as IEC 61010-1. Hence, safety of personnel, plants and equipment is fully and highly aware of</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.1.6</td><td>System Configurations
The SCPS shall be designed by taking into account the following important implementation issues which are described further in details in Annex 1 Control and Protection System Configurations.</td><td></td><td></td><td></td><td></td></tr>
</table>

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
4.2	SYSTEM HIERARCHICAL STRUCTURE The system architecture shall be configured based on multi-tier hierarchical structure. The multi-tier hierarchical structure levels as a minimum for the SCPS are: 1) Level 1 – Station Level 2) Level 2 – Bay Level				
	Bidders shall be able to propose a solution, e.g., using a redundant box (Redbox), so that the systems are connected and functioning as required. When a Redbox is used with a relay, due to hardware or speed issues with massive SV traffic, a relay shall be connected to a station-level side, not to a process-level side				
	Redundant equipment should be on different source of power supply from main				
	Relay of 115 kV systems will be separated into Main 1 and Main 2 Relays. The mechanism control and protection of selecting either Main 1/BCU and or Main 2/BCU to perform the functions of control and protection, in case of commanding/controlling from SCADA center, shall be configured within the IEDs.				
(ADDENDUM)	Network redundancy protocol for each topology shall be Parallel Redundancy Protocol (PRP) and/orHigh Availability Seamless Redundancy (HSR) protocol for zero-time recovery.				
(ADDENDUM)	Time synchronization shall be accomplished via IEEE 1588 or IRIG-B.				
	An Engineering Workstation might have 1 connection port, but can interchangeably connect to main or redundant connection.				
	The Contractor shall provide IED servers, i.e. Bay Controller, at bay level to perform all allocated distributed functions of bay level functionality.				
	Engineering workstation shall be provided to ensure secure information flow with the SCADA/DMS located at ADDC engineering offices. The station bus shall provide the communication network (IEC 61850), integration, data exchange and data flow between station-to-bay level and bay-to-bay level.				
4.2.1	Station Level The main characteristics of the station devices shall be; 1) multifunction IED 2) use of IED technology 3) IEDs conform with IEC 61850 standard 4) interface to user through device HMI and remote client such as Engineering Workstation integrated as part of SCPS through networked communication. 5) flexible applications and functions 6) capability to interoperate with other IEDs from several different manufacturers to exchange information and use the information for own functions 7) IEC 61850 server which provide rich source of IED information such as settings, configuration information, events, alarms, power system information, fault records, COMTRADE fault waveform files, etc. a. Station-level data management, data storage, and data retrieval mechanisms: include support for IEC 61850 information models, historical data, configuration data, diagnostic and maintenance data, and files (e.g. non-operational, configuration, application programs, software updates). b. Station-wide collection of maintenance data, diagnostic data, and statistical data for (1) primary system components, (2) secondary system components, and (3) application functions				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	8) self-monitoring and supervision 9) certified and type tested as protection grade device 10) enact programmable logic: any IED or other devices which can act as a programmable logical controller should be able to be programmed using methods stipulated in IEC 61131 11) powered from substation auxiliary DC system 12) interfaced to the station bus via hardened managed Ethernet Switch 13) failure not affecting other functions or bay level 14) Hardwired parallel connections to the primary equipment or apparatus (switchgears and instrument transformers). (“This part belongs to the Bay Level”).				
	Local Repository and System Logs: The following data structures form the core of the SCPS system. They include six system logs that chronologically capture the stations operational history.				
	1) Local Repository The Repository represents the present state of the station. It shall hold the IEC 61850-based information models for the primary system and secondary system components, including off-the-shelf and programmable logic applications.				
	IEC 61850 provides information models for most of the available system data, and those models can be extended to include new components. Although it is not desirable for the Repository to store all data available in the station, it must at least include all data subscribed by station or enterprise clients.				
	The SCPS Systems shall implement all of IEC 61850’s ASCI service models, with the following exceptions: GSSE Control Block and the Sampled Value Class Model. Clients and servers using the Repository shall find all of the other services available. The Repository must be maintained in a replaceable flash memory module. Battery power is an unacceptable approach to maintaining non-volatile data memory.				
	2) StatusLog The StatusLog is a chronological record of recent changes in either primary or secondary system status, either commanded or uncommanded. - The StatusLog shall hold events for the most recent 100 records. It shall be backed up in archives, each archive containing events for a particular month. - All StatusLog entries shall include a time-stamp, identify the system item that changed, identify the new status, and identify the cause (or agent) of the change.				
	3) CommandLog - The CommandLog is a chronological record of recent control commands to station equipment (e.g. Trip, Close, Open, Close, Raise, Lower, Enable, Disable, and set-points) issued by System Clients. -The CommandLog shall hold commands issued during the most recent 100 days. It shall be backed up in archives, each archive containing control commands for a particular month. - All CommandLog entries shall include a time-stamp, identify the system item being controlled, identify the state being commanded, and identify the source of the control command.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	4) ChangeLog - The ChangeLog is a chronological record of recent changes made by an HMI unit to system and device configuration parameters. The ChangeLog shall hold changes issued during the most recent 100 days. It is backed up in archives, each archive containing changes for a particular month. All ChangeLog entries shall include a time-stamp, identify the system or IED parameter being changed, identify the new state, and identify the source (i.e. agent) of the change.				
	5) SubLog The SubLog is a chronological record of changes made by clients using the IEC 61850 substitution services. The SubLog shall include all substitution events, including a return to process values, that have occured during the most recent 100 days.				
	6) FileLog The FileLog is a chronological record of recent file transfers and file deletions involving any intelligent station device (e.g. BCU, SCPS Systems, HMI). The FileLog shall include all such file events that have occured during the most recent 100 days. It shall be backed up in archives, each archive containing file events for a particular month. All FileLog entries shall include a time-stamp, identify the file reference, identify the action taken, and identify the source (i.e. agent) of the action.				
	The station functions and the Logical Nodes (LN) shall be distributed and allocated to station level devices. 1) Engineering Workstation (EWS) with HMI 2) SCADA gateway to PEA SCADA/DMS: Protocol for communications between the SCADA/DMS and substations is DNP3.0 over IP. Communications between the SCADA gateway and IED servers are via SCPS Systems 3) SCPS Systems 4) Station optical fibre ring bus, providing the means by which devices and applications exchange data within the station 5) Station-operator HMI or station level operator interface (SLOI) 6) Time synchronization server with GPS receiver				
	Operating Systems (OS) of HMI and Engineering Workstation shall be Windows. OS of Gateway and SCPS Systems shall be a stable one, such as Linux.				
4.2.2	Bay Level The main characteristics of the bay devices shall be; 1) multifunction IED 2) use of IED technology 3) IED conform with IEC 61850 standard 4) performing distributed bay level functionalities 5) interface to user through device HMI and remote client such as Engineering Workstation 6) compact with integrated functionalities in one device. Integrated as part of SCPS through networked communication. 7) flexible applications and functions 8) ability to activate or deactivate the main functions 9) capability to interoperate with other IEDs from several different manufacturers to exchange information and use the information for own functions 10) IEDs which provide rich source of IED information such as settings, configuration information, events, alarms, power system information, fault records, COMTRADE fault waveform files, etc.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	11) self-monitoring and supervision 12) certified and type tested as protection grade device 13) enact programmable logic.interfaced to the station bus via hardened managed Ethernet Switch 14) possibility to minimise the use of external electromechanical auxiliary relays and lockout relay. powered from substation 125V auxiliary DC system interfaced to the station bus via hardened managed Ethernet Switch 15) proxy to legacy devices or non-IEDs (as an alternative, a dedicated protocol converter with generic logical nodes shall be provided) 16) failure not affecting other functions within or external to the particular bay or level 17) hardwired parallel connections to the primary equipment or apparatus (switchgears and instrument transformers). The IEC 61850 process bus shall also be implemented.				
	The bay functions and the Logical Nodes shall be distributed and allocated to bay level devices, i.e. protection devices and single control device.				
	Data flow of operational real time data and control, through client-servers communication, shall be ensured between IEDs and station level clients. Each IED shall be able to support multiple clients (at least 5 clients). The IEDs shall be able to provide configuration information and IED specific information including COMTRADE files, IED native individual parameters, etc. to the Engineering Workstation at station level.				
(ADDENDUM)	"Typical of Protective relay functions can be categorized as: 1) 115 kV Bus Protection (Main 1 and Main 2) 87B, 95B 2) 115 kV Line Protection (Main 1 and Main 2) 21/21N, 67/67N, 25, 27/59, 79, 50BF 3) 115 kV Transformer Protection (Main 1 and Main 2) 87T,87REF, 50/51, 50N/51N, 51GB, 50BF 4) Others 115 kV Protections 5) 22 or 33 kV Feeder Protection 50/51, 50N/51N, 67/67N, 25, 79, 50BF, 81, 27/59, 60 6) Others MV Protections All protection functions of the protective relay shall be completely programmed from manufacturer's factory "				
4.2.3	System Logical Architecture The main features of the SCPS architecture are:				
	1) distributed architecture using Ethernet Local Area Network (LAN) station bus with 1 Gbits/s optical fibre ring topology				
	2) All IEDs and clients are connected to the station bus via hardened managed Ethernet Switch certified to IEC 61850-3 and IEEE 1613				
	3) Distributed multifunction bay IEDs or relays integrated in single panel per bay				
	4) Transformer Automatic Voltage Control/Regulator device shall be located in a separate panel				
	5) For AIS (Air Insulated Switchgear?) substations, the bay panels may be located in Prefabricated relay house(s) at the substation switchyard				
	6) Local displays (mimic screen) in independent panel at each Prefabricated relay house to provide safe operational awareness for operation and maintenance purposes, unless PEA states otherwise				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	7) SCPS Systems to perform station level functions including control and automation functions				
	8) Station Level Operator Interface (SLOI) to perform Station-operator HMI				
	9) Gateway for communication interface with PEA SCADA/DMS. The gateway shall be supplied by the Contractor				
	10) Engineering Workstation to manage the SCPS, communication network and substation information, and to provide applications utilizing the substation information				
	11) Time synchronization server (NTP, and IEEE 1588 or IRIG-B, with the latest version, if IEEE 1588 is not available, Server) synchronizing with GPS master clock receiver to provide time source for time synchronization of all SCPS components. Depending on synchronization standard used, a dedicated communication interface and network might be provided for time synchronization, such as for IRIG-B.				
4.2.4	Supporting SCADA/DMS Operations The Dispatchers shall be able to control station equipment and gather system data via DNP3.0 over IP command and polling messages transmitted from the SCADA/DMS control centre. Implementation of DNP 3.0 over IP protocol shall meet at least ALL DNP 3.0 over IP standard requirements.				
	The DNP communications shall be supported by the Gateway via a process that links and converts IEC 61850 data from the Local Repository to the desired DNP values and formats. These resulting DNP data shall be stored and maintained in a separate DNP database that can be accessed by DNP data communication services. This approach provides two significant advantages: (1) the continual DNP data conversion process is independent of (i.e. not interrupted by) DNP message processing, and (2) the DNP database allows the HMI to quickly respond to message requests. DNP commands shall likewise be translated to use IEC 61850 control blocks and procedures for controlling system equipment.				
4.6	SYSTEM SECURITY The software system shall be the latest version, and free of viruses when the Contractor delivers. During the guarantee period, the Contractor shall keep the software up-to-date. After the guarantee period, the Contractor shall propose an option to update the software to PEA; the update shall not be via the internet.				
	The Contractor shall recommend security capabilities that conform with standard IEC 62351 for SCPS security, and IEC 27032 for other relevant Information Technology (IT) operations. The recommendations shall provide reasonable protection for a reasonable cost, so as to significantly reduce the risk of damage, loss of information, unauthorized use, or impairment of use or control of the station facility.				
4.9	AUTOMATIC CONTROL FUNCTIONS Automatic function is like programmable inside the memory of Relay or BCU, and shall be included in Relay or BCU, for example, Sequential Switching, Load Shedding, Automatic Transfer Switch etc.				
	The automation function shall be programmed and performed at station level in the station intelligent electronic device IED. However, the automated sequence may be initiated by operator at the Station-operator HMI or Station Level Operator Interface (SLOI).				

<table>
<tr><th>Clause No.</th><th>Clause Name</th><th>Conformance Status (C,A or N)</th><th>Standard Equipment Status (S or M)</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td rowspan="2">4.10</td><td>MEASUREMENT FUNCTIONS
Measurement of electrical quantities such as voltage, current, active power, reactive power, etc. shall be taken directly, without separate interposing or transducers, by the IED from substation current and/or voltage transformer(s). Measurement from DC and 400V AC voltages may be derived from substation auxiliary AC and DC systems.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>The measurement functions are modelled and grouped according to the IEC 61850 Logical Node Group which begins with the character M.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.11</td><td>MONITORING FUNCTIONS
The monitoring function provides substation device or equipment indications and information</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.12</td><td>CONTROL INTERLOCKING FUNCTIONS
All station and bay interlocking schemes shall be provided and controlled by intelligent electronic control devices using GOOSE messages.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.13
(ADDENDUM)</td><td>INTERFACING, ADVANCE ANALYTICS AND ARCHIVING FUNCTIONS
The interfacing and archiving functions are performed at the following locations:
1)Station-operator HMI or station level operator interface (SLOI)
2)SCADA gateway for remote interface to PEA SCADA/DMS
3)Prefabricated relay housing screen mimic (If applicable)
4)Engineering workstation
5)Emergency control interface (Backup Mimic)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>(ADDENDUM)</td><td>Table 4.5 – Interfacing Issues
<table><tr><th>System Component</th><th>Comments</th></tr><tr><td>Station-operator HMI or Station Level Operator Interface (SLOI)</td><td>Station Level Operator Interface (SLOI) shall provide station-operator HMI functions such as substation local control, monitoring, and handling of local alarms and events. The detail requirements shall be referred to the relevant Section of the Specification, see Table 11 (“should be made sure that this Table is put in this Specification”)</td></tr><tr><td>SCADA Gateway(SGW)</td><td>The SCADA Gateway forms the interface between the substation and Network Control Centre(s), and between the substation and other substations using standard SCADA protocol. This is interconnection device that supports the full stack of relevant protocol and security to interface or communicate with the SCADA/DMS and other future systems that access to station for operation and maintenance.</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td>
<table>
<tr><th>System Component</th><th>Comment:</th></tr>
<tr><td>Engineering Workstation – Engineering Unit Interface (EUI) (See more details in Clause 8.4.)</td><td>Engineer Interface Unit. It is the IEC 61850 client that gathers information from various IED devices and enables the operator to supervise and have local or remote control. Include OPC-Server

Engineering Workstation manages the SCPS, communication network and substation information, and to provide applications utilizing the substation information. The Engineering Workstation functions are:

1) Real time data historian & analysis
2) Communication network management
3) System access control and cyber security management
4) SCPS monitoring, diagnostics and maintenance
5) Substation IED interrogation and monitoring
6) Substation Protection, Automation and Control system and IED configuration management
7) GOOSE messaging management (configurable via the work station)
8) Disturbance and fault information handling, analysis and evaluation (via Program Fault Record)
9) Engineering HMI
10) Web browser and interface (for equipment setting)
11) Substation status display
12) Sequence of events and alarm analysis
13) Data archiving, trending and historical analysis
14) Automatic fault report generation and notification
15) Substation equipment monitoring
16) Substation documentation management

The HMI software shall be capable of IED devices management function such as setting and resetting of all Protective relays and other by remote via Router.</td></tr>
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<table>
<tr><th>System Component</th><th>Comment:</th></tr>
<tr><td>Merging Unit (MU)</td><td>The Merging Unit is a physical unit used for time-dependent combination of current and/or voltage data from secondary converter. A merging unit can be a component part of the instrument transformer or a separate unit.

Typical locations for MU shall be as follows:
1) MV switchgear: low-voltage compartment of each cubicle (mounted on MV switchgear).
2) HV switchgear: marshalling cubicles/junction boxes, local control cabinets.
3) HV/MV power transformer: local control cabinets.
4) Automatic switching capacitor bank: local control cabinets.</td></tr>
<tr><td>Protocol Convertor (i.e., IEC 61850 Gateway)</td><td>Element that allows the integration of devices that have not yet implemented the IEC 61850 architecture. The IEC 61850 Gateway collects the information through the communication protocol of the devices and it adapts this information by integrating it in the new IEC 61850 format.</td></tr>
<tr><td>Communications Network</td><td>The communication network is constituted by an Ethernet network (ISO/IEC 8802-3), as it is shown in Part 8-1, 9-1, 9-2 of the IEC61850 standard.</td></tr>
<tr><td>Ethernet Switch</td><td>They are the local network connection elements. Enables network access to the different units of the system avoiding collisions.</td></tr>
<tr><td>Time Reference Unit (GPS clock)</td><td>Time server with GPS synchronization. It is the main synchronization source of the system. NTP, and IEEE 1588 (PTP-the latest version) or IRIG-B protocol enable the synchronization through a local communication network of the different devices. The Contractor shall provide time accuracy corresponding to the proposed synchronization protocol for PEA approval.</td></tr>
<tr><td>Intelligent Electronic Devices (IED)</td><td>IEC 61850 clients which receives the information from the bay level IEDs, and support the communication with the SCADA system, thus executing the logics at station level. The RTU functions and the logics may be separated into independent IEDs.</td></tr>
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</td><td></td><td></td><td></td><td></td></tr>
<tr><td>(ADDENDUM)</td><td>
<table>
<tr><th>System Component</th><th>Comments</th></tr>
<tr><td>Emergency Control Interface, if requested by PEA</td><td>Emergency Control for each bay (for CB operation only) in the event of Control Bay Control IED failure.
1) The Emergency Control interface includes: Pushbutton to trip or open the circuit breaker
2) Pushbutton to close the circuit breaker with hardwire interlocking command supervision and synchronizing bypass switch
3) Hardwire connection</td></tr>
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Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
4.14.4	Technical IEC 61850 Functions 1) All devices shall conform with IEC 61850 standard and the following requirements: a. Interoperability, i.e. ability to communicate and to exchange information with other IEDs from several different manufacturers and use the information for own functions b. Free configuration and allocation of functions Future proof, independent of communication technology and evolving system requirements c. Successfully pass IED conformance test based on IEC 61850 part10 as necessary d. Information management by standardizing the Data Models and Abstract Communication Services e. Engineering and configuration management using XML based Substation Configuration Language (SCL) and IEC 61850 conformant Engineering Tools. f. Client-Server communication including relevant services such as reporting, data sets, control blocks and self-description via MMS protocol g. Peer-to-peer communication using IEC61850-9-2 SV and IEC61850 GOOSE tripping channels. h. IED native Ethernet port that support all relevant IEC 61850 protocols i. Engineering access, event report collection, and non-IEC 61850 setting transfer via TCP/IP mechanisms 2) The following device information shall be provided: a. IED Capability Description (ICD) b. Configured IED capability Description (CID) c. Model Implementation Conformance Statement (MICS) d. Protocol Implementation Conformance Statement (PICS) e. Protocol Implementation Extra Information for Testing (PIXIT) 4) The IED shall support IEC 61850 standard in terms of the following: a. Buffered reports supported b. Unbuffered reports supported c. Customization of the reports and data sets d. Ability to freely rename data sets, and logical devices e. Ability to add prefix and suffix to logical nodes f. Use specific logical node name for commonly used information rather than generic data references (such as GGIO) g. Ability to change data sets and reporting configuration via Configuration Tool h. Ability to download CID file directly into IED via Configuration Tool i. Ability to download CID file directly into IED via Ethernet using standard TCP/IP mechanism from remote such as from HMI. j. Flexible configuration of data sets k. Ability to setting logical devices, logical nodes, and their contents l. Ability for user to query IED directly and to verify which IEC 61850 configuration file (.CID file) is active within the IED				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	5) The IED shall also support the IEC 61850 GOOSE implementation in terms of the followings: a. At least 8 of unique GOOSE messages capable to be published b. At least 24 GOOSE messages to be subscribed c. Capability of monitoring GOOSE message quality d. Capability of processing incoming data elements and their associated quality e. Capability of monitoring message and data quality as permissive prior to use of the incoming data. At the time of configuration, the end user can choose to ignore the possibly corrupted data if the data or message quality fails to prevent an unwanted operation. f. Capability of creating GOOSE data set that include Boolean values and non-Boolean data type, such as Analog values g. Capability of accepting and processing data sets from other IEDs that contain Boolean and non-Boolean data types h. Ability to support priority tagging of GOOSE messages for optimizing latency through Ethernet Switch. i. Ability to support VLAN identifiers to facilitate segregation of GOOSE traffic on Ethernet network. j. Ability to support custom editing of data sets published in the GOOSE messages. k. Ability to change data sets, GOOSE parameters, GOOSE publication, and GOOSE subscription via Configuration Tool. l. Ability to support Recovery delay demands acc. to IEC 61850-5 Ed. 2 on Ethernet network. 6) The Network shall also support the Recovery Time implementation in terms of the followings: a. IEC 61850-8-1 Station Bus. • GOOSE traffic not delayed beyond a critical threshold due to failover. • Unless stated otherwise, PRP and/or HSR provide seamless recovery, i.e. zero recovery time, on Station Bus for demanding applications. If a RedBox (Redundant Box) is needed in the proposed topology, the Bidder shall provide specification and quotation of the RedBox for PEA approval.				
	7) The IEDs specified in the specifications are for the followings: a. Control devices, i.e. station and bay control devices b. IED Protective relay or devices c. IED for Protection for each bay level shall be physically independent. d. The IEDs are devices incorporating one or more processors with the capability to receive or send data/control from or to an external source. The IEDs shall also be capable for peer-to-peer communication (IEC61850 GOOSE) and Client/Server communication. (Such as Reporting by Exception) e. All IEDs supplied shall pass the IEC 61850 Conformance Test based on IEC61850-10. The IEC 61850 Conformance Test Certificate from an independent laboratory shall be provided as evidence and part of the tender submission. The laboratory shall be accredited by UCA International Users Group with ISO/IEC17025 certification with certification. f. The IEDs shall not show any non-conformance to IEC 61850-3, 6, 7-1, 7-2, 7-3, 7-4&8-1, and 9-2 (2011). g. Markings and Labelling Data. Clearly inscribed labels or markings shall be provided on the devices to describe the manufacturer name, model number, application and ratings.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	8) Device Electrical Parameter Values. The standard device electrical parameter values are: a. The device shall be suitable for operation using substation auxiliary DC system. b. The device shall not mal-operate on DC auxiliary supply interruption or application/restoration or when energized from inverted polarities. c. The device shall also be stable and not affected by slow decay, surges, dips, ripples, spikes, capacitive coupling, DC earth fault, transient and switching disturbances. Indication shall be made available in the event of DC failure.				
4.14.5	Station Level Devices Functions The main characteristics of the station devices shall be: 1) Multifunction IED 2) Use of IED technology. 3) IED conform with IEC 61850 standard 4) Interface to user through device HMI and remote client such as Engineering Workstation 5) Integrated as part of SCPS through networked communication flexible applications and functions. 6) Capability to interoperate with other IEDs from several different manufacturers to exchange information and use the information for own functions. 7) IEC 61850 server which provide rich source of IED information such as settings, configuration information, events, alarms, power system information, fault records, COMTRADE fault waveform files and can be send COMTRADE files to HMI by automatically, etc. 8) Self-monitoring and supervision. 9) Certified and type tested as protection grade device. 10) Interfaced to the station bus via hardened managed Ethernet Switch. 11) Failure not affecting other functions or bay level. 12) The station functions and the Logical Nodes shall be distributed and allocated to station level devices.				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
4.14.6 (ADDENDUM)	Bay Level Devices Functions 1)Switchgear Manual Close and Open Control Operation a.Control of Circuit Breaker b.Control of Isolator Switch c.Control Mode Selection (Local/Remote/OFF) d.Select-Before-Execute Control Command Procedure- Manual Close Synchronism & Voltage Check e.Synchronism check - Voltage difference, Phase angle difference, Slip frequency/difference f.Voltage check				
	2)Dead line-live bus (DLLB), Live line-dead bus (LLDB), Dead line-dead bus (DLDB)				
	3)Interlocking (Command Supervision) 27UV a.Bay Interlocking b.Station-Wide Interlocking (Peer-to-peer) c.Under voltage Interlocking				
	4)Event and Alarm Handling				
	5)Monitoring a.Switchgear Status Indication and Mimic b.Bay Alarm Annunciator				
	6)Bay IED Operations and Status, CB Alarm a.Auto and Manual Trip Counter b.IED Self Supervision and Monitoring				
	8)Measurements a.Current (Amps) b.Voltage (V) c.Power (MW and MVAR) d.Frequency (Hz) e.Power Factor				
4.14.6.1	IED Bay Control Unit (BCU) without Protective Relay This specification refers to smart bay implementations as BCU. As such, they are assumed to have sufficient local processing, memory, programmable logic, and communication resources to support expanded responsibilities and capabilities. In case of an IED BCU (without Protective Relay), the programmable logic should be included in the IED. When these resources are combined with support for the IEC 61850 communications standard, BCU gain flexibility and power that can significantly elevate their system roles and provide enormous flexibility.				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
4.14.8	Enhanced Automation Functions The SCPS systems shall perform enhanced automation functions, including the following: 1) Heartbeat function for IED health and on-line status monitoring 2) Maintenance of TRIP Counters for breakers 3) Rate of Change (ROC) Limit Checking 4) Breaker operating time checks (should perform at HMI) 5) Substation-wide, automated control sequences: Automatic Transfer Switch(ATS), Bus Coupler Throw-over Scheme (CTO), Line Throw-over (LTO) & Bus Throw-over (BTO), Load Shedding / Load Restoration, and Voltage Selection (VT connection is Hardwire, Logic at Software at Bay Level). 6) Station-wide interlocking (GOOSE interlocking at Bay level) 7) Protection applications (Breaker Failure Protection) (at Bay level, both Main & Back up protection)				

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Bid No. : ร่างเอกสารประกวดราคา

Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5 5.1	SCPS: CONTROL REQUIREMENTS 5.1 SCOPE OF WORK The scope of work shall include 1) the preparation of a SCPS Detailed Design Documents for approval by PEA prior to commencement of system production. The initial list of required data points and typical screen displays are provided in Annexes 4 and 5, respectively. A printout report shall be kept electronically as a raw log file, and can be printed out according to the format guideline given in Annex 5.				
	2) the development of the control software to perform all substation manual and automatic functions.				
	3) all necessary hardware/software required for integrating the SCPS to the Distribution Management System (DMS) Mater Station located at each Area Distribution Dispatching Center (ADDC).				
	4) the preparation and maintenance to as built stage of a database, which documents all data points within the substation.				
	The Contractor shall submit performance test report and interoperability test report from independent testing laboratories for PEA approval.				
5.2	SOFTWARE/FIRMWARE The major system functions to be implemented in the SCPS software area shall be as follows: 1) Substation equipment control 2) Substation equipment indications 3) Substation equipment alarm and event handling facilities 4) Graphical information display 5) System configuration and database maintenance 6) Manual and automatic control function maintenance 7) Interlocking maintenance 8) Serial ports protocol assignment 9) DMS Interface software maintenance 10) IED devices management 11) System Disturbance Analysis 12) Measurement values including Load reports and Load curves creation and display 13) Printing 14) Automatic self-diagnostic 15) Help information 16) Archiving				

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Bid No. : ร่างเอกสารประกวดราคา

Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5.3	FUNCTIONAL REQUIREMENTS				
5.3.1	General The SCPS shall perform the following functions: 1) Control electric power substation equipment 2) Monitor the status of electric power substation equipment 3) Acquire operating data from electric power substations 4) Operate autonomously and on command from the DMS and a local user interface (HMI).				
5.3.2	Input/Output Point Types The SCPS shall include facilities for handling all analog input, status input, and control output points. Requirements for each type of I/O point are described in the following sub-clauses.				
	Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.				
5.3.2.1	Analog Input Analog measurement from CT/VT shall be processed in IED relay and/or BCU.				
5.3.2.2	Status Input Status Inputs shall be processed in IED relay and/or BCU.				
5.3.2.3	Control Output The SCPS shall include the following types of control points to support control actions initiated by the DMS master stations or, where applicable, the integral programmable logic facilities of the SCPS: 1) On/Off Device Control 2) Raise/Lower Control 3) Setpoint Control				
5.4	SYSTEM PERFORMANCE REQUIREMENTS				
5.4.1	Response to a Control The delay between the completion of an operator's keying sequence and the response of the substation equipment as observed on the HMI display shall not exceed 2.0 second. This time does not include the operating time of the primary equipment.				
5.4.2	Status Change The delay between the occurrence of a spontaneous status change at the substation and the appearance of the corresponding indication on the HMI display shall not exceed 1.0 second.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays. The response time requirement shall also be applied for the information acquired from such Protective relays when they operated.				
5.4.3	Measured Values Measured values, which are rapidly varying quantities, shall be updated on the HMI display at least every 2 seconds				
5.4.4	Alarms/Events The delay between the occurrence of an alarm/event at the substation and the appearance of the corresponding logged message on the HMI display shall not exceed 1.0 second.				
	Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays. The response time requirement shall also be applied for the information acquired from such Protective relays when they operated				
5.4.5	Alarm Generation The alarms shall be stored in buffer in chronological order with 10 ms or better resolution time and shall be possible to be displayed on HMI display or printed on a printer. The following conditions listed below shall be considered as alarms and shall give both audible and visual indications. 1) Failure of equipment or predefined change in the condition of equipment into the alarm state. These include both substation equipment and SCPS equipment. 2) Surpassing of predefined upper/lower limits by the Analog values including fault current, harmonics, voltage sag, and voltage swells. 3) Executed command not successful. 4) Uncommanded status change. 5) Disagreement of normally open or normally closed contacts input for the substation equipment status.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5.4.6	Sequential Events Recording The sequential events recording shall include all events, which can be of interest, occuring in the substation. The normal events shall be stored in database in chronological order with 10 ms or better resolution time and shall be displayed on HMI display or printed out on a printer. The system shall automatically log the following events: 1) All alarm conditions as defined in Clause 5.4.5 2) All alarmed failure of substation and SCPS equipment returning to normal 3) All alarmed Analog value points returning to normal. 4) All status changes. 5) All operator intervention. 6) Placement and removal of all tags. 7) Changing of the measured value limits and scaling: the Contractor shall describe in detail how the two repositories are kept in sync 8) Any other important events input by PEA.				
5.4.7	High-resolution Sequence-of-Events (SOE) The SCPS shall include a high-resolution Sequence-of-Events (SOE) reporting capability. As a minimum, the status input points shall be assigned to SOE reporting in addition to normal status reporting.				
	The SCPS shall detect changes in the state of SOE points, record the date and time of change with a resolution of ± 1 ms relative to the SCPS internal clock, inform the DMS that SOE data has been recorded, and report SOE data to the DMS upon request.				
	The time tagging of all SOE inputs within a substation shall be made in the BCU and shall be synchronized to ensure that SOE inputs connected to different control cabinets satisfy the time resolution requirement. Time delays introduced by Contractor-supplied auxiliary relays used to acquire SOE status inputs from substation control circuits shall be consistent between devices to prevent time tag “skewing”.				
	Where the SCPS is used to acquire any of the specified data I/O via an interface to the IED devices such as substation Protective relays, the resolution time requirement shall also be applied for the information acquired from such Protective relays when they operated.				
	To ensure that SOE data is not lost or overwritten until the DMS acknowledges receipt of the data, a SCPS buffer capable of storing a minimum of 512 events shall be provided. The SCPS shall be able to retransmit stored SOE data if requested by the DMS.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5.4.8	Storage of System Disturbance and Power Quality Data				
5.4.8.1	System Disturbance Data The SCPS shall include a function for storing AC voltage and current waveform data prior to, during, and following power system disturbances detected as user-defined events. The stored data shall be made available to the DMS master station for post-disturbance analysis and shall be in an IEEE COMTRADE format.				
	At least 12 user-defined data track shall be provided for each measuring point of each switchgear bay. Each track shall be capable of storing data up to 1 second in one time window with a user-defined trigger. The capabilities for storing data of multiple disturbances such as auto-reclose on fault shall be provided.				
	Typical triggers include those that shall occur when events such as overvoltage and undervoltage are detected. In general, however, the ability to define event triggers based on calculated as well as actual data points shall be provided.				
	When an event occurs, the SCPS shall save the contents of the associated time window together with a time-stamped event flag. This flag shall identify the event type and shall be made available to the DMS master station for use by its Disturbance Data Collection function. The user shall be able to specify whether the contents of the saved buffer should remain frozen until collected or released by the DMS.				
	Where the SCPS is used to acquire any data of the specified functions via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.				
5.4.9	Fault Current Detection				
	The SCPS shall provide the facilities for detecting and reporting a fault current level for each of its AC current inputs. The function shall provide for the recording, time tagged to 10 millisecond, of an excursion outside user definable limits, together with the peak deviation and the time that the measured value returned to a point below the user defined trigger level. The limits of the fault current amplitude resolution shall be 20 times normal full load, and the trigger point for saving the record shall be user definable.				
	The SCPS shall save the fault current detection event as a database record for reporting to the HMI and the DMS master as required. The SCPS shall be capable of saving at least 256 such events in its database.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	Where the SCPS is used to acquire any data of the specified functions via an interface to the IED devices such as substation Protective relays or power meters, the overall system performance and responses as called for in theses specifications shall not be compromised.				
5.4.10	Tagging and Labelling				
	The proposed SCPS shall provide labelling and tagging facilities which allow the substation operator to indicate the presence of control suppression, live line working, advise of the control status of a device and allow limited control of the system's scanning and alarm processing functions. The OFF NORMAL and EVENTS list entries shall record the application of these tags and labels. The minimum requirement for labels and tags shall be but not limited the following:				
5.4.10.1	Out of Scan Tag				
	A visual tag indicating that scanning of a device has been suppressed by the operator. All other system functions shall also be suppressed for such a point. It shall be possible to place screen comments regarding the status of tagged points.				
5.4.10.2	Alarm Suppression Tag A visual tag indicating that alarm processing on a system point (a device or measured value) has been suppressed by the operator. Status/Value information shall continue to be scanned and displayed. Provision shall be made for single point and functional group alarm suppression.				
5.4.10.3	Live Line Working Tags A visual tag indicating that some of PEA workers are doing some maintenance task on the line outside substation territory while the line is being energized. When this tag is applied to any line protection circuit breaker, selection of an auto-reclosing device of such circuit breaker shall result in a message to the operator e.g. CB_ AUTO-RECLOSING CONTROL BLOCKED.				
5.4.10.4	Control Suppression Tag A visual tag indicating that primary system equipment appearing on the HMI operator display has been suppressed. Selection of a device with control suppressed shall result in a message to the operator e.g. CB_ CONTROL BLOCKED.				
5.4.10.5	Method of Application of Tags and Labels The tags and labels shall be quickly and easily applied by the operator. The preferred method shall be by using cursor positioning and a simple keystroke sequence to apply any of the tag to any point/device on operating diagrams.				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5.4.11	Interlocking The closing or opening operation of primary equipment such as circuit breakers, disconnectors, earth switches, etc. shall be supervised by the appropriate predefined interlocking. The facilities for interlocking maintenance shall also be provided.				
5.4.12	Load Reports and Load Curves Analog measured and calculated values shall be recorded in historical data file at the end of each half hour (snapshot) for subsequence reports creation.				
	As a minimum, daily load report, monthly load report, peak & light load report and yearly load report of each incoming and outgoing shall be provided and shall be in accordance with typical printout report format provide in Annex 5.				
	These reports shall be able to be shown on the HMI display, with the required format at any time by the operator.				
	Screen menus shall be provided for operator to select the required period of information by entering date(s), month and year. Daily and monthly load curve creation shall also be provided by using such stored data.				
	The delay between the completion of an operator's keying sequence and the response of any report or curve display as observed on the HMI display shall not exceed 5 second.				
5.4.13	IED Device Management The HMI software shall be capable of IED device management via the router and firewall for remote the IED devices management function such as setting and resetting of all Protective relays and BCU.				
5.4.14	Archiving The SCPS system shall be able to take care of archiving data on measurements, events, alarms, and fault records to hard disk. The hard disk shall be capable of storing all of above data for at least 1 year. The data stored on a hard disk shall be in the form of standard databases and shall be processed by means of the system itself as well as by means of the other standard packages such as Ms-Access, etc.				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
5.4.15	Operation Screen Displays The operation screen displays for the monitoring and control of the substation shall include but not be limited to the following: 1) Detailed equipment status, and network configuration information. 2) Visual indication of device setting, selection, operation and interlocking 3) Service and measurement values, including analog measurements and their limit setting. 4) Alarm annunciation. 5) Visual record of system alarms, including fault information, events and SOE. 6) A means of displaying the status of devices that are not monitored automatically but are under the substation operator's control such as application of tags or labels. 7) If keyboard inputs have not been received for 1 hour then the screen shall revert to screen saver mode. 8) IED internal events.				
5.4.16	System Management Displays These are displays for monitoring and controlling the SCPS system. They shall include: 1) System Configuration Control Display 2) HMI Assignments Display, for the management of HMI modes 3) Display for monitoring and controlling the SubLAN				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page or Clarification Letters
6	SCPS: Protection requirements Access to relay display and setting parameters will be keyed by different authorization levels (password).				
6.1	GENERAL REQUIREMENTS				
6.1.1	Digital Fault Recorder (DFR) for a switching substation is an optional, which PEA shall specify its requirements case by case. At the minimum, the DFR shall conform with the specification given in Annex 10 of Spec RSUB-010-2560.				
6.1.2	Reference Standards All equipment, materials, fabrication and testing under this Specification shall conform to the latest applicable standard specifications and codes contained in the following list, or to equivalent applicable standard specifications and codes established and approved in the country of manufacturer of the equipment. Where standards are mentioned by name, equivalent applicable standards may be used. IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-27, IEC 60068-2-78, IEC 60255-3, IEC 60255-27, IEC 60255-26, IEC 60870-5-1012, IEC 60947-1, IEC 60947-7-1, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5; see more details in Clause 2.2 Specific Relevant Standards. Any details not specifically covered by these standards shall be subject to the approval of PEA. In the event of contradictory requirements between such standards and this Specification, the terms of the Specification shall govern.				
6.1.3.1	Details of Switchboard Construction. Each control switchboard, each control and protective relay switchboard, each protective relay switchboard and each interposing relay cabinet, shall consist of an assembly made from not less than No. 3.0 mm levelled sheet steel and formed steel members as required to form a rigid self-supporting structure. No butt surface joints shall be made on the outside surfaces of switchboards and cabinets. No holes or fasteners shall be visible as viewed from the front of the panels. Switchboards and cabinets shall be designed to have bottom sheets and each bottom sheet shall be provided with gland plate which shall be made of a non-magnetic metal. Each gland plate shall be provided with adequate quantity of holes for control cable entrance from underneath the switchboard and cabinet. They shall be furnished with channel bases. The front and rear panels of the switchboards and the cabinets shall have bent angle or flange edges with an outside radius not exceeding 10 mm. The construction details of the switchboards shall be as shown on Drawing No. OOT10N. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Exterior and interior surfaces shall be cleaned by sanding and steam cleaning, ground smooth, filled, primed, sanded and shall be finish-painted inside and outside with RAL 7032.				
6.1.3.2	Equipment shall be protected against electrical and electro-magnetic disturbance and shall particularly comply with IEC 60255-27 and IEC 60255-26 standards.				
6.2	DETAILED REQUIREMENTS				
6.2.2.2	Bay Control Unit (BCU) Refer to Sub-Clause Bay Control Unit 8.3.8 for Hardware Requirement.				
6.2.2.3	I/O Interface All signals shall be processed by the SCPS from the SCPS Systems.				

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6.2.2.4	Trip circuit All the relays used for tripping shall still operate if the DC supply voltage is equal to 80% of the rated voltage. All tripping control circuits for the CB shall be interrupted for the qualitative and quantitative tests. These circuits shall be located at the same test block provided to test the relay with currents and/or voltages.				
6.2.2.7	DC-Supply The power supply shall be based on 125 V or 48 V lead-acid station battery depend on each PEA Substation.				

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Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
7	COMMUNICATION SYSTEM REQUIREMENTS				
7.1	GENERAL REQUIREMENTS The communication requirements shall be based on IEC 61850 standards, in particular IEC 61850-3: General Requirements, 61850-5: Communication Requirements For Functions and Device Models, IEEE 1615: Recommended Practice for Network Communication in Electric Power Substations and IEEE 1613: Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations.				
7.2	FUNCTION HIERARCHY, INTERFACE, AND TOPOLOGY the optical SCPS or CGW ports shall meet the following requirements: 1) 2.5 kV optical isolation 2) Electrical EIA RS-232 DB-25 or DB-9 male connector (DTE-DCE selectable) 3) Optical connector supporting ST or LC multimode 4) Power budget of 12 db (optical fibre cable 62.5/125 micron) 5) Data rate from 300 to 19,200 bps 6) Auto-powered from RS-232 interface 7) Environmental capability of 0 to 50 °C, 5 to 95% relative humidity				
7.3	COMMUNICATION NETWORK The communication network infrastructure shall satisfy the following requirements: 1) Access control and cyber security especially for remote access 2) Configuration, system and network management 3) Deterministic predictable network (collision-free environment) with the utilization of a dedicated managed Ethernet Switch 4) Deterministic real time network capability 5) Environmentally hardened network devices and components, rated for operation in HV substation environment 6) Flexibility and scalability for system change or expansion 7) Fully duplex communication backbone using high speed 1Gbit/s optical fibre ring Ethernet local area network (LAN) topology 8) Fully duplex Ethernet communication connection to IEDs using either 100Base Fx (Preferred) or 100BaseT 9) Integration of intelligent devices 10) Priority queuing support 11) Simultaneously support multiple applications including virtual LAN (VLAN) support 12) Time synchronization over Ethernet.				

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	Internet protocol suite (IPS) shall be used for the transfer of operational and non-operational data as well as configuration management. The followings shall be considered: 1) Development plan for IP address allocations. PEA will manage the IP addressing. Details on PEA IP addressing management is in Annex 6. 2) Private and fixed IP addressing shall be employed on the substation network. 3) SCPS connected to an enterprise or WAN must pass through a properly configured router with firewall and cyber security measures as described in Clauses 8.4.3 System Access Control and Cyber Security Management and 11.5 Substation Access Control and Cyber Security measures. However, the provision of the router with firewall is not under the scope of this specification, and shall be supplied by PEA ICT Division.				
7.3.1	Communication Network Device – Ethernet Switch All Ethernet switches shall be certified and type tested as protection grade devices.				
(ADDENDUM)	The main characteristics of the Ethernet Switch shall be designed for continuous operation in a high voltage substation and shall conform to the industrial environment performance, according to IEEE 1613 – class 1 for the Ethernet Switch used in station bus level and IEEE 1613 - class 2 “ error free” for Ethernet Switch used in process bus level, for real-time control and EMI immunity and shall pass a type test according to IEC 61850-3. And the requirements stated in Clause 4. 6 System Security. Ethernet Switch at a station bus level shall be L3 type, and those at a process bus level shall be L2 type.				
	Network Redundancy using IEC 62439 1) IEC SC65C WG15 published IEC 62439 “Highly Available Automation Networks” 2) IEC 62439-3 Clause 4 Parallel Redundancy Protocol PRP 3) IEC 62439-3 Clause 5 High Availability Seamless Ring HSR				

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<tr><th>Clause No.</th><th>Clause Name</th><th>Conformance Status (C,A or N)</th><th>Standard Equipment Status (S or M)</th><th>Proposed Data</th><th>Referred to Page</th></tr>
<tr><td>(ADDENDUM)</td><td>The basic requirements of the managed Ethernet switch are:
<table><tr><th>Requirement</th><th>Comments</th></tr><tr><td>Network Device Type</td><td>1) Fully Managed Ethernet switch
2) Fanless
3) Modular Design</td></tr><tr><td>Auxiliary Supply</td><td>1) 125 VDC nominal voltage (substation DC system) with minimum range 80-120% of nominal voltage, or
2) 230 VAC nominal voltage with ±10% of nominal voltage</td></tr><tr><td>Temperature Range</td><td>1) Extended temperature range operation
2) -40 to +85 °C (IEC 61850-3)</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td><table><tr><th>Requirement</th><th>Comments</th></tr><tr><td>EMC and Environmental Type Tests</td><td>1) EMI-hardening
2) Protection Graded
3) IEC 61850-3 and IEEE 1613
4) Type test certificate to be provided as evidence</td></tr><tr><td>Mounting</td><td>1) Panel
2) DIN rail
3) Rack-Mount</td></tr><tr><td>Port Speed</td><td>1) 1 Gbps (Station Bus Backbone), 100 Mbps (IED connection)</td></tr><tr><td>Port Type</td><td>1) 1000Base FX (For Backbone)
2) 100BaseTX (For Segment or IED)</td></tr><tr><td>Switching Method</td><td>1) Store and forward</td></tr><tr><td>Switching Delay</td><td>1) < 10 µsec (100 Mbps)</td></tr><tr><td>Priority Queues Number</td><td>1) Minimum 2</td></tr><tr><td>Backbone Media</td><td>1) Optical fibre (at the process level)
2) RJ45 Copper (at the station level)</td></tr><tr><td>Backbone Interface (Station bus communication)</td><td>1) SFP LC type optical fibre connector</td></tr><tr><td>Segment or IED Interface (within panel</td><td>1) RJ45 port
2) Option for ST optical fibre connector (multi-mode optical fibre)</td></tr><tr><td>SCADA monitoring and management</td><td>1) Switch should compliant with IEC 61850-90-4 MMS bridge modelling</td></tr><tr><td>Network Management Tools</td><td>1) SNMP or MMS with the latest version
2) Web-based
3) Remote Monitoring</td></tr><tr><td>Cyber Security</td><td>1) User passwords
2) SSH/SSL encryption
3) Encrypted authentication and access security
4) MAC based port security
5) VLAN (IEEE Std 802.1Q</td></tr><tr><td>Others</td><td>The switch shall support transmissions of GOOSE messaging.</td></tr><tr><td>Quality Assurance</td><td>1) ISO 9001:2000</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>(ADDENDUM)</td><td><table><tr><th>Requirement</th><th>Comments</th></tr><tr><td>Operating Temperature</td><td>-40 to +85 °C</td></tr><tr><td>Power Supply</td><td>Dual redundant, load sharing, hot-swappable</td></tr><tr><td>Ethernet Module</td><td>Field replaceable</td></tr><tr><td>Ports</td><td>High density: 28 ports, all gigabit capable
RJ45 with a secure copper connector, or fiber for future expansion</td></tr><tr><td>Fiber Type Connector</td><td>ST, or LC</td></tr><tr><td>Network Switch and Time Synchronization</td><td>Transparent Clock</td></tr><tr><td>Coating</td><td>Conformal coating to prevent mould / corrosion</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
</table>

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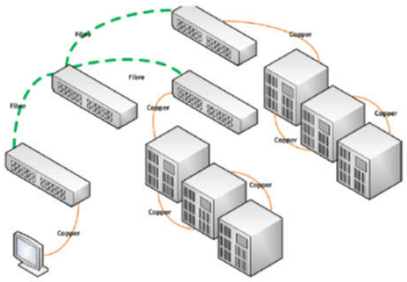
Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
7.3.2	Communication Network Device – Media The selection of the network media in the substation shall consider the followings: 1) Required data speed/throughput 2) Linear distance 3) Physical routing 4) Electromagnetic interference (EMI) and ground potential rise (GPR) susceptibility 5) Number of network-connected devices 6) Substation wiring practices/procedures 7) Fibre Monitoring: All fibre media should support DDM (Digital Diagnostics Monitoring) and follow industry-standard SFF-8472.				
	The communication media to be used in the substation shall be copper and/or optical fibre as depicted in Figure 7.2.  Figure 7.2 – Substation Network Media				
	The type of the optical fibre to be used in the substation as the network backbone interface (station bus communication) shall be as the following: Optical Fibre Type: 1000Base-X, Single mode glass; Wavelength: 1310nm; Speed: 1 Gbps; Connector: ST or LC (SFP) Other requirements of the optical fibre cabling are: 1) Vermin proof with mechanical protection 2) Redundant spare optical fibre cable shall be provided as per project specific requirements 3) 100% spare optical fibre cores in each cable shall be provided, i.e., full redundant fibre cores should be provided in each cable 4) Optical fibre cables lay in PVC conduit if mechanical protection is not provided. 5) Power budget calculation shall be approved by PEA				
	The copper cable used in the network segment inside a panel shall be UTP or STP Ethernet cable (depend on the induced and radiated noise within the panel) as the following: Rating: CAT 5; Name: 100 BASE TX; Connector: RJ45; Speed: 100Mbps; Standard: IEEE Std 802.3-2005 and EIA/TIA 568A/B Rating: CAT 5E (Preferred); Name: 100 BASE TX; Connector: RJ45; Speed: 100Mbps; Standard: IEEE Std 802.3-2005 and EIA/TIA 568A/B Rating: CAT 6; Name: 100 BASE TX; Connector: RJ45; Speed: 100Mbps; Standard: IEEE Std 802.3-2005 and EIA/TIA 568A/B				

<table>
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<tr><td></td><td>Alternatively, multi-mode optical fibre may be used in the network X, subject to Ethernet switch port availability and PEA approval, as the following:
<table><tr><th>Optical Fibre Type</th><th>Wavelength</th><th>Speed</th><th>Connector</th></tr><tr><td>Multi-mode glass</td><td>850nm, 1310nm</td><td>100Mbps</td><td>ST</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.4</td><td>COMMUNICATION SERVICES TO BE SUPPORTED
Communication services to be supported are summarized in Table
<table><tr><th>Service Model</th><th>Description</th><th>Services</th><th>Requirement</th></tr><tr><td>Server</td><td>Represents the external visible behaviour of a device. All other ACSI models are part of the server</td><td>ServerDirectory</td><td></td></tr><tr><td>Application Association</td><td>Provision of how two or more devices can be connected. Provides different views to a device: restricted access to the server's information and functions</td><td>Associate Abort Release</td><td></td></tr><tr><td>Logical Device</td><td>Represents a group of functions; each function is defined as a logical node</td><td>LogicalDeviceDirectory</td><td></td></tr><tr><td>Logical Node</td><td>Represents a specific function of the substation system, for example, over voltage protection</td><td>LogicalNodeDirectory
GetAllDataValues</td><td></td></tr><tr><td>Data</td><td>Provides a means to specify typed information, for example, position of a switch with quality information, and timestamp</td><td>GetDataValues
SetDataValues
GetDataDefinition
GetDataDirectory</td><td></td></tr><tr><td>Data Set</td><td>Allow to group various Refer to Data set data together</td><td>GetDataSetValue
SetDataSetvalue
CreateDataSet
DeleteDataSet
GetDataSetDirectory</td><td></td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td><table><tr><th>Service Model</th><th>Description</th><th>Services</th><th>Requirement</th></tr><tr><td>Substitution</td><td>The client can request the server to replace a process value by a value set by the client, for example, in the case of an invalid measurement value</td><td>SetDataValues</td><td></td></tr><tr><td>Setting Group Control</td><td>Defines how to switch from one set of setting values to another one control and how to edit setting groups</td><td>SelectActiveSG
SelectEditSg
SetSGValues
ConformEditSGValues
GetSGValues
GetSGCBValues</td><td></td></tr><tr><td rowspan="3">Reporting and Logging</td><td rowspan="3">Describes the conditions for generating reports and logs based on parameters set by the client. Reports may be triggered by changes of process data values (for example, state change or dead band) or by quality changes. Logs Logging can be queried for later retrieval.
Reports may be sent immediately or deferred (buffered). Reports provide change of state and sequence-of-events information exchange</td><td>Buffered RCB: Report
GetBRCBValues
SetBRCBValues</td><td></td></tr><tr><td>Log CB:
GetLCBValues
SetLCBValues</td><td>For Measurement Only</td></tr><tr><td>Unbuffered RCB:
Report
GetURCBValues
SetURCBValues</td><td>Option</td></tr><tr><td></td><td>Log:
QueryLogByTime
QueryLogAfter
GetLogStatusValues</td><td>Option</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
</table>

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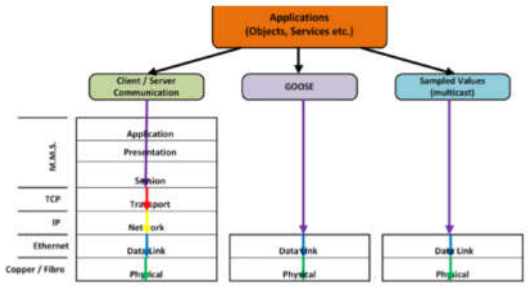
<tr><td></td><td>
<table>
<tr><th>Service Model</th><th>Description</th><th>Services</th><th>Requirement</th></tr>
<tr><td>Generic substation events (GSE)</td><td>Provides fast and reliable system-wide distribution of data; peer-to-peer exchange of IED binary status information
GOOSE means Generic Object Oriented Substation Event and supports the exchange of a wide range of possible common data organised by a DATA SET
GSSE means Generic Substation State Event and provides the capability to convey state change information</td><td>GOOSE CB:
SendGOOSEMessage
GetGoReference
GetGOOSEElementNumber
GetGoCBValues
Set GoCBValues</td><td></td></tr>
<tr><td></td><td></td><td>GSSE CB:
SendGSSEMessage
GetGsReference
GetGSSEElementNumber
GetGsCBValues
Set GsCBValues</td><td>Not Implemented</td></tr>
<tr><td>Transmission of Sampled Values</td><td>Fast and cyclic transfer of sample, for example of instrument transformer</td><td>Multicast SVC:
SendMSVMessage
GetMSVCBValues
SetMSVCBValues</td><td>Future
Not Implemented</td></tr>
<tr><td></td><td></td><td>Unicast SVC:
SendUSVMessage
GetUSVCBValues
SetUSVCBValues</td><td>Future
Not Implemented</td></tr>
<tr><td>Control</td><td>Describes the services to control, for example, devices or parameter setting groups</td><td>Select
SelectWithValue
Cancel
Operate
CommandTermination
TimeActivatedOperate</td><td></td></tr>
<tr><td>Time and Time Synchronization</td><td>Provides the time base for the device and system</td><td>Services in SCSM</td><td></td></tr>
<tr><td>File transfer</td><td>Defines the exchange of large data blocks such as programs</td><td>GetFile
SetFile
DeleteFile
GetFileAttributeValues</td><td></td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.5</td><td>COMMUNICATION PROFILE
Communication profiles the Contractor must comply with are Application (A) Profile, and Transport (T) Profile, which can be found in the following services:
1) Client/Server services (Core ACSI Services)
2) GOOSE/GSE Management Services
3) Time Synchronization
 

Figure 7.3 – Communication Profile for the Substation</td><td></td><td></td><td></td><td></td></tr>
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7.5.1	Communication Profile – Client/Server Services The client/server communication profile shall be used when declaring support for the services shown in the following tables of IEC 61850-8-1. 1) Table 2 Service Requiring Client/Server Communication Profile 2) Table 3 Service and Protocols for Client/Server Communication A-Profile 3) Table 4 Service and Protocols for Client/Server Communication T-Profile				
7.5.2	Communication Profile – GOOSE/GSE Management Services For the GSE Management and GOOSE communication profile when declaring support for the services, refer to Table 6 Service Requiring GSE Management and GOOSE Communication Profile of IEC 61850-8-1. For service and protocols for GSE Management and GOOSE communication A and T profiles, refer to Tables 7 and 8 of IEC 61850-8-1, respectively.				
7.5.3	Communication Profile – Time Synchronization Time synchronisation for the SCPS shall be accomplished using NTP protocol with direct interface to the Ethernet network through connectionless user datagram protocol (UDP) at transport layer.				
	This communication profile shall be used for any implementation claiming conformance to this standard and declaring support for objects containing an attribute of type TIMESTAMP.				
7.6	INTRA-SUBSTATION AND REMOTE CONTROL CENTER COMMUNICATIONS Communications between substations, and between a substation and a remote control center shall bevia a secured router/CGW. Engineer WAN shall be installed at all substation to facilitate fault investigation and event record view via remote access to IED including the disturbance recorder.				
	The communications should comply with IEC 61850, Part 90-1 for communications between substations, and Part 90-2 for communications between substation and a control center.				
	In case that IEC 61850, Part 90-2 has not been released yet, the Contractor shall propose communications between a substation and a control centre for PEA approval.				
7.7	STATION TIME SYNCHRONIZATION Time synchronisation of all IEDs and IEC 61850 based SCPS components in the substation shall be accomplished via NTP Server and modulated IEEE 1588 or IRIG-B with GPS master clock receiver(s).				
	The Contractor shall make sure that synchronization across a given SCPS system, via NTP together with IEEE 1588 or IRIG-B, shall work properly.				

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<tr><td></td><td>Time synchronisation server shall provide the time source for time synchronisation of all SCPS components. The time shall be distributed to all substation IEDs via the station bus. The expected time stamp resolution of devices shall be 1ms (IEC 61850 Time Performance Class T1) and the expected accuracy (±) between network devices shall be 0.1ms.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The expected time stamp resolution of devices shall be 1ms (IEC 61850 Time Performance Class T1) and the expected accuracy (±) between network devices shall be 0.1ms.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>One (1) GPS satellite disk and receiver shall be provided for time synchronization purposes at each SCPS system station site. The physical connection and installation of the GPS hardware components shall simple, not requiring any RF or GPS expertise. Any software for configuring or operating the unit shall be provided with the system.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The basic requirements of the Time Server are:
<table>
<tr><th>Requirement</th><th>Comments</th></tr>
<tr><td>Device output protocol type</td><td>1) NTP Server (for network connection, with RJ45 Ethernet Interface)
2) IEEE 1588 or IRIG-B (for direct-wired connection)</td></tr>
<tr><td>Auxiliary supply</td><td>1) 125VDC nominal voltage (substation DC system)
2) Minimum range 80-120% of nominal voltage</td></tr>
<tr><td>EMC and environmental type tests</td><td>1) Withstand substation EMI
2) EMI-hardening</td></tr>
<tr><td>Protocol for NTP server</td><td>1) NTP
2) Internet protocol suite standard for time synchronization
3) Network Time Protocol v4.0 or higher
4) Should be compatible with IEEE 1588/IEC 61588 standard</td></tr>
<tr><td>Time source</td><td>Redundant Global Positioning Satellite (GPS) system receivers with antennae and wiring</td></tr>
<tr><td>Expected accuracy (±) between Network devices</td><td>1) 0.1ms (Expected Time Synchronizing of IED Clocks – one order of magnitude better than IED time stamp resolution)
2) Note: Typical Accuracy
3) 1-2 ms (NTP)
4) 1 microsec (IEEE 1588 or IRIG-B)</td></tr>
<tr><td>Interface</td><td>1) Ethernet (NTP, and IEEE 1588)
2) Direct-Wired Co-axial (IRIG-B)</td></tr>
<tr><td>Maintainability requirement</td><td>1) Maintenance port to perform the management, configuration, test and maintenance functions
2) Possibility to verify the time server accuracy and precision
3) Possibility to diagnose and troubleshoot problems</td></tr>
<tr><td>Other requirements</td><td>High precision clock discipline algorithms to counter inaccuracies caused by jitter and wander</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Time synchronisation between devices which require high accuracy equal or less than 0.1 msec. shall be accomplished via IEEE 1588 or IRIG-B, direct-wired synchronization network.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>BCU and TRU units must support both NTP, and IEEE1588 (PTP) or IRIG-B protocols.</td><td></td><td></td><td></td><td></td></tr>
</table>

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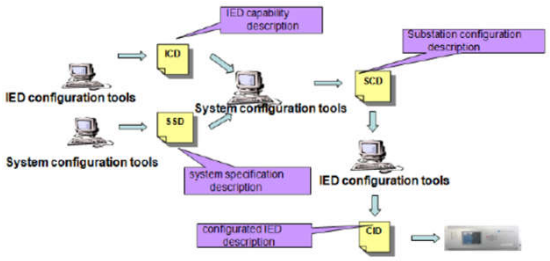
7.8	SUBSTATION CONFIGURATION LANGUAGE (SCL) A standard configuration language SCL, (Substation Configuration Language), based on the XML (Extensible Markup Language) shall be used to define the characteristics of each IED with regards to communication configuration, data model and parameters. SCL is a file format for describing communication related IED (Intelligent Electronic Device) configurations and IED parameters, communication system configurations, switchyard (function) structures, and the relations between them. The main purpose of this format is to exchange IED capability descriptions, and SA system descriptions between IED engineering tools and the system engineering tool(s) of different manufacturers in a compatible way; see Fig. 7.4.				
	SCL types are classified with different suffixes including ICD, CID, SSD, and SCD as described, previously, in Clause 4.14.1: IEC 61850 Configuration functions for Tools and Process.  Figure 7.4 – IED and System Configuration Tools and SCL				
	The SCL shall describe a model of: 1) The primary (power) system structure: which primary apparatus functions are used, and how the apparatus are connected. This results in a designation of all covered switchgear as substation automation functions, structured according to IEC 81346. 2) The communication system: how IEDs are connected to subnetworks and networks, and at which of their communication access points (communication ports). 3) The application level communication: how data is grouped into data sets for sending, how IEDs trigger the sending and which service they choose, which input data from other IEDs is needed. 4) Each IED: the logical devices configured on the IED, the logical nodes with class and type belonging to each logical device, the reports and their data contents, the (pre-configured) associations available; and which data shall be logged. 5) Instantiable logical node (LN) type definitions. The logical nodes as defined in IEC 61850-7x have mandatory, optional and user defined DATA (here abbreviated DO) as well as optional services, and are therefore not instantiable. In this document, instantiable. LNTypes and DOTypes are defined as templates, which contain the really implemented Dos and services. 6) The relations between instantiated logical nodes and their hosting IEDs on one side and the switchyard (function) parts on the other side.				

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<tr><td>7.8.1</td><td>IED Configuration
Any IED supporting the IEC 61850 standard will be accompanied by a configuration file with ICD (IED Capability Description) which defines capacities of the IED. This file will start each project with the installation values, such as addresses, initial parameter values, etc. generating a new CID (Configured IED Description) file.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.8.2</td><td>System Configuration and Specification
The Contractor shall provide all relevant SCL files including System Specification Description (SSD), Substation Configuration Description (SCD), and make sure for IED can be automatically configured from the power system design.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The SCPS configuration shall be done via a management application, as described in Clause 8.4.6 SCPS System and IED Configuration Management. All IEDs shall be configured using SCL-compliant tools, files, and procedures as described in IEC 61850, Part 6.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.9
7.9.1</td><td>COMMUNICATION PERFORMANCE
Communication Message Performance
The seven message types specified must meet the following performance requirements:
<table>
<tr><th colspan="2">Message Type</th><th>Description</th><th>Typical use</th><th>Performance</th></tr>
<tr><td rowspan="3">1</td><td></td><td>Fast messages – Simple binary code containing data, command or simple message. Triggers the receiving IED to respond immediately.</td><td></td><td></td></tr>
<tr><td>1A</td><td>Fast messages for Trip (Note: For Performance Class P2/P3, the total transmission time shall be below the order of a quarter of a cycle)</td><td>Trip command to XCBR, intertrip and scheme discriminations</td><td>P1 – 10ms
P2 – 3ms
P3 – 3ms</td></tr>
<tr><td>1B</td><td>Fast messages for Others</td><td>Fast response function other than trip command such as interlocking, blocking, etc.</td><td>P1 – 100ms
P2 – 20ms
P3 – 20ms</td></tr>
<tr><td>2</td><td></td><td>Medium speed messages</td><td>Calculated r.m.s. values</td><td><100ms</td></tr>
<tr><td>3</td><td></td><td>Low speed messages containing complex messages that may require time tagging</td><td>Slow speed auto-control functions, transmission of event records, set point, etc.</td><td><500ms</td></tr>
<tr><td>4</td><td></td><td>Future Raw data messages</td><td>Voltage & current phasor from instrument transformer with sampling rate of 480 Hz. These values are for protection & control usage</td><td>P1 – 10ms
P2 – 3ms
P3 – 3ms</td></tr>
<tr><td>5</td><td></td><td>File transfer functions
Time synchronization messages</td><td>Lowest priority. Transfer large file of recording, information, setting etc.</td><td>>1000ms</td></tr>
<tr><td rowspan="2">6</td><td>T1</td><td rowspan="2">Control and Protection Events</td><td>Used to synchronize internal clock of IED in SCPS. Include all station, bay and process level IE</td><td>±1ms</td></tr>
<tr><td>T2</td><td>T1 -Time tagging of events
T2 -Time tagging of zero crossings and data for distributed</td><td>±0.1ms</td></tr>
<tr><td rowspan="4">7</td><td>T3</td><td rowspan="3">Instrument transformer</td><td rowspan="3">Time tagging for sampled values for protection and control purposes</td><td>±25μs
±4μs
±1μs</td></tr>
<tr><td>T4</td></tr>
<tr><td>T5</td></tr>
<tr><td></td><td>Command messages with access control</td><td>Used to transfer control for security</td><td>>1000ms</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
</table>

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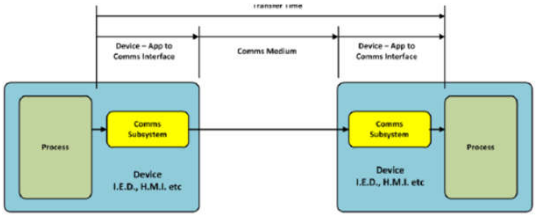
	Table 7.8 – Message Performance Performance Class P1 Distribution with low requirements — M1 Quality metering up to the 5th harmonic P2 Transmission bay — M2 Quality metering up to the 13th harmonic P3 Transmission bay with top performance requirements — M3 Quality metering up to the 40th harmonic				
	The definition of the transfer time for the communication message performances is explained in the Figure below. The given performance times are referring to the total transfer time "t" that includes the IEDs internal processing time as well as the transmission time used over the communication network.  Figure 7.4 – Transfer Time Definition				
7.9.2	Communication System Performance The following parameters shall be measured at station-operator HMI level to evaluate system performance for worst case scenario which includes normal, abnormal, emergency, and post-fault state of operations.				
	Typical values measured at the station-operator HMI or the Station Level Operator Interface (SLOI) is listed in the following table: Table 7.9 – HMI Performance Parameters — Performance Exchange of display (first reaction) — <1.5 s Presentation of a binary change in the process display — <1 s Presentation of Analog change in the process display — <1.5 s From order to process output — <1 s From order to updating the display — <2 s				
7.10	COMMUNICATION SYSTEM AVAILABILITY The Contractor shall refer to Clause 4.3 System Performance of this specification, and IEC 61850-7, for details on communication system availability.				
7.11	COMMUNICATION SYSTEM MAINTAINABILITY The SCPS designs that do not required periodic preventive maintenance and inspection are preferred by PEA. If periodic maintenance is required, it shall be possible to perform all such work in the field without requiring the associated media, and/or the communication system to be off. The Contractor shall refer to IEC 61850-7, for details on the maintainability.				

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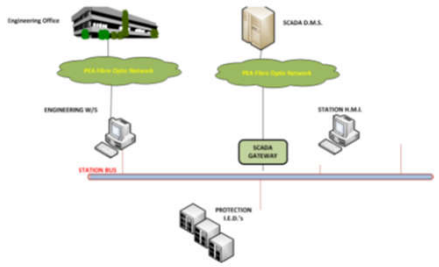
<tr><td>7.12</td><td>IEC 61850 ACSI CONFORMANCE STATEMENTS
Refer to Tables A.1-A.4 of IEC 61850-7-2 for the IEC 61850 ASCI Conformance Statement for PEA requirements, i.e.
1) ACSI Basic Conformance Statement
2) ACSI Models Conformance Statement, and
3) ACSI Service Conformance Statement.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.13</td><td>INFORMATION MANAGEMENT SYSTEM
The structure of information management system for the SCPS is depicted in Figure 7.5.
 
Figure 7.5 – Information Management System</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The Information Management System shall consist of:
Table 7.10 – Substation Data and Information
<table>
<tr><th>Topic</th><th>Comment</th></tr>
<tr><td>Substation Data and Information</td><td>The substation data types are;
Operational Data: Typical instantaneous measurements values (current, voltage, frequency), indications & status change/event that are conveyed to SCADA master station and Station-operator HMI/SLOI
Non- Operational Data: All other non-instantaneous substation information, such as oscillography waveform records, fault data, configuration files and all information from IED
Control Commands: Control command messages sent by operators and control processes to optimise and restore the state of power system
IT Infrastructure Data: All communication & network-related data such as network & device status, activities, etc.
Data priority and time requirements shall be determined with operational data and control command at the highest priority.</td></tr>
<tr><td>Communication Infrastructure</td><td>1) Networked communication architecture using Ethernet and Web technology
2) Network devices and time synchronisation
3) Substation clients such as Engineering Workstation
4) High speed database server - Data Historian (Real-time database) and Relational Database
5) Network and system management system</td></tr>
<tr><td>Applications Utilising the Information</td><td>1) SCPS functions and applications
2) SCADA
3) Condition-based (optional) and self-monitoring of primary and secondary equipment
4) Network and system management
5) Configuration and setting management
6) Fault handling, analysis, evaluation & diagnostics
7) Alarm and event handling and analysis
8) Trending
9) Asset maintenance and management</td></tr>
<tr><td>Users/Clients (both local and remote users) of the Information and Applications</td><td>1) SCADA gateway and control centre
2) Substation Operator through Station-operator HMI/SLOI
3) Engineering Workstation
4) Protection System Engineering
5) Operation & Maintenance
6) Asset management</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
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	<table><tr><th>Topic</th><th>Comment</th></tr><tr><td></td><td>7) Planning</td></tr><tr><td>Substation Access Control and Cyber Security</td><td>1) Access Control such as user ID authentication, password management, access management 2) Cyber security measures</td></tr></table> **Table 7.11 – Sources of Substation Data** <table><tr><th>Topic</th><th>Comment</th></tr><tr><td>Sources of Substation Data</td><td>1) IED 2) Sensor 3) Allow IED data sharing with other multiple clients connected to the communication network.</td></tr></table>				
7.14	REDUNDANCY The Contractor shall comply with IEC 61850-3 Reliability Requirement. Full power redundancy with support for two power supplies shall also be provided. These power supplies can be of the same type, or of mixed voltage type to ensure reliability through diverse power sources.				
7.15	CABLE MANAGEMENT The Contractor shall provide all interconnecting wires, cables, connectors, LAN cables, and other wiring required by the SCPS.				
	The Contractor shall submit the results of the survey of the cable route and equipment installation location, including workshop drawings and installation procedures, to PEA for approval before installation.				
	All necessary cabling works with the substation building such as installation of cable trays, cable ducts, cable ladders and support or any other such work to facilitate cabling between the equipment under the scope of this specification and PEA equipment shall be considered as part of the scope ofwork for the Contractor. PEA will not be responsible for any future claims for minor works within the substation building to facilitate cabling.				
	The LAN supporting the distributed BCU, Protective relays and MU shall utilize fibre optic cables, shall provide to be glass type to satisfy the distribution distances and overall performance requirements and shall be approved by PEA.				

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<tr><td>8
8.2
8.2.3</td><td>SYSTEM COMPONENT REQUIREMENTS
INTELLIGENT ELECTRONIC DEVICE (IED)
Device Electrical Parameter Values
The standard device electrical parameter values are:
<table>
<tr><th>Electrical Parameter Requirements</th><th>Standard Values</th></tr>
<tr><td>Nominal/Rated Auxiliary Operating Voltage (large range)</td><td>125 VDC</td></tr>
<tr><td>Operative Ranges Auxiliary Operating Voltage (80% to 110% range)</td><td>88 to 138 VDC</td></tr>
<tr><td>Rated DC Burden (Watts)</td><td>To be declared by the manufacturer</td></tr>
<tr><td>Total Device Accuracy (%) (Protective relay of Device)</td><td>± 5%</td></tr>
<tr><td>Total Device Accuracy (%) (Control Device)</td><td>± 1%</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The standard nominal range of ambient temperature is -10°C to 55°C.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.5</td><td>Technological Conformance and Mechanical Requirements
The electrical technological and mechanical hardware tests and standards for the devices are:
<table>
<tr><th>Electrical Technological Conformance and Mechanical Requirements</th><th>Standards</th><th>Type Test Descriptions</th></tr>
<tr><td>Mechanical Stress – Vibration and Shock Stress</td><td>IEC 60255-21-1</td><td>Vibration test</td></tr>
<tr><td></td><td>IEC 60255-21-2</td><td>Shock and bump test</td></tr>
<tr><td></td><td>IEC 60255-21-3</td><td>Seismic Test</td></tr>
<tr><td>Insulation</td><td>IEC 60255-27
IEC 60255-1</td><td>High Voltage Test and Impulse Voltage Tests.</td></tr>
<tr><td>Electromagnetic Compatibility – Immunity</td><td>IEC 60255-26</td><td>Damped oscillatory wave test</td></tr>
<tr><td></td><td>IEC 60255-26
IEC 61000-4-4 Class 4</td><td>Fast transient test</td></tr>
<tr><td></td><td>IEC 60255-22-5
IEC 61000-4-5 Class 3</td><td>Surge Test</td></tr>
<tr><td></td><td>IEC 60255-22-6
IEC 61000-4-6 Class 3</td><td>Conducted radio interference test</td></tr>
<tr><td></td><td>IEC 60255-26
IEC 61000-4-2 Class 3</td><td>Electrostatic discharge test</td></tr>
<tr><td></td><td>IEC 61000-4-11 for AC IEC 60255-3 and IEC 60255-26 for DC</td><td>Variations and interruptions in AC and DC auxiliary voltages</td></tr>
<tr><td></td><td>IEC 61000-4-3 Class 3</td><td>Electromagnetic fields</td></tr>
<tr><td></td><td>IEC 61000-4-8 Class 5</td><td>50Hz power frequency magnetic fields</td></tr>
<tr><td>Electromagnetic Compatibility – Noise Emission</td><td>CISPR 11, Class A, Group I. IEC 60555-2</td><td>Conducted RF interference on power supply terminals and radiated interference. Harmonics for AC supply</td></tr>
<tr><td></td><td>CISPR 14</td><td>Flicker</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.6</td><td>Operating and Reset Time
The required operating and reset time of the protection device are:
<table>
<tr><th>Protection</th><th>Maximum Operating Time</th><th>Maximum Reset Time</th></tr>
<tr><td>Main Line Differential Protection</td><td>40 ms</td><td>40 ms</td></tr>
<tr><td>Maximum Fault Clearing Time</td><td>150 ms</td><td></td></tr>
<tr><td colspan="3">Note:
1) CB operating time is assumed to be less than 40 ms for 275kV & 500kV system voltage and 50 ms for 115kV system voltage.
2) Relay operating time includes relay fault inception detection time, microprocessor time and relay output contact time.
3) Telecommunication carrier send/receive time (from relay to relay) is assumed to be less than 20 ms.
4) Telecommunication transmission delay is assumed to be less than 10 ms.
5) Handle a delay variation or asymmetric delay of not more than 0.25ms</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.7
(ADDENDUM)</td><td>The Human Machine Interface (HMI) for protection device shall be provided as a user or operator interface. The HMI provides device parameter display, device operational record/status display and device interrogation facility.
The basic requirements of the HMI are:</td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td>
<table>
<tr><th>Basic Requirements</th><th>Details</th></tr>
<tr><td>Human Machine Interface (HMI)</td><td>Alpha-numeric massage display, Liquid Crystal Display (LCD) to display information.</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.8
(ADDENDUM)</td><td>The HMI for control device shall be provided as a user or operator interface. The HMI provides device parameter display, device operational record/status display and device interrogation facility.
<table>
<tr><th>Basic Requirements</th><th>Details</th></tr>
<tr><td>Human Machine Interface (HMI)</td><td>Alpha-numeric massage display, Liquid Crystal Display (LCD) to display information.</td></tr>
<tr><td>Information Navigation</td><td>User friendly HMI hierarchical navigation structure</td></tr>
<tr><td>Mounting/Location</td><td>Front of the device</td></tr>
<tr><td>View or Display</td><td>1) View or display device settings and configurations
2) View or monitor service and measurement/metering values
3) View or display event and relevant fault information
4) View or display IED internal events
5) View or display device information/status</td></tr>
<tr><td>Device Control</td><td>1) Control switching devices with necessary software interlocking for bay control device
2) Select-before-execute command procedure
3) Control mode selection (Local/Remote)
4) Interrogate or access device information/status
5) Programmable logic control</td></tr>
<tr><td>Local Information and Indication View</td><td>1) Bay Indications
2) Fault information depending on IED functions
3) IED event records and status
4) Measurements under normal load conditions</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td>(ADDENDUM)</td><td>
<table>
<tr><th>Basic Requirements</th><th>Details</th></tr>
<tr><td>Change or modify</td><td>1) Change or modify device settings and configurations
2) Change or modify device setting groups</td></tr>
<tr><td>Testing and Monitoring</td><td>1) Monitoring of device self-supervision status
2) Testing and commissioning assistance</td></tr>
<tr><td>Memory Type</td><td>Non-volatile. Settings view not to be lost in the event of supply failure.</td></tr>
<tr><td>Password</td><td>Password restriction for change or modify the IED setting/configuration and commissioning assistance</td></tr>
</table>
</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.9</td><td>Relay Indicator
The indications shall be visible with or without front cover mounted. The indication shall be stored and will not be lost in the event of DC supply failure.</td><td></td><td></td><td></td><td></td></tr>
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<tr><td>8.2.10</td><td>Event Recording
<table>
<tr><th>Basic Requirements</th><th>Details</th></tr>
<tr><td>Number of Event Record</td><td>Capacity of at least 100 event records, and at least 5 records of oscillographic recordings</td></tr>
<tr><td>Timed & Date</td><td>Time & date stamped by relay real time clock</td></tr>
<tr><td>Relay real time clock</td><td>Resolution 1 ms or less</td></tr>
<tr><td>Memory Recording Sequence</td><td>First in first out (FIFO)</td></tr>
<tr><td>Display View</td><td>LCD display
Remote/PC access via the appropriate communication facility</td></tr>
<tr><td>Chronological Event Record</td><td>1) Relay tripping
2) Binary I/O operation or change state
3) Relay internal algorithm pickup/drop-off
4) Relay internal events
5) Relay self-supervision/monitoring state
6) Setting change</td></tr>
<tr><td>Memory Type</td><td>Stored in non-volatile memory</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.11</td><td>Fault Recording
The basic requirements of the relay fault recording are
<table>
<tr><th>Basic Requirements</th><th>Details</th></tr>
<tr><td>Number of Fault Record</td><td>To be declared by the manufacturer. Minimum 5 fault records.</td></tr>
<tr><td>Timed & Date</td><td>Time & date stamped by relay real time clock</td></tr>
<tr><td>Recording Duration</td><td>1) Dynamic fault record duration up to 5.0 second
2) Pre and post fault duration</td></tr>
<tr><td>File Format</td><td>COMTRADE format (IEC 60255-24)</td></tr>
<tr><td>Sampling Frequency</td><td>1) To be declared by the manufacturer
2) Minimum 1 kHz</td></tr>
<tr><td>Memory Recording Sequence</td><td>First in first out (FIFO)</td></tr>
<tr><td>Number of Analog and Binary Channels</td><td>To be declared by the manufacturer</td></tr>
<tr><td>Oscillographic Recording and Event Information</td><td>1) Voltage waveform
2) Current waveform
3) Zero sequence voltage & current
4) Activated element
5) Binary Input and Output Status
6) CB status</td></tr>
<tr><td>Triggering</td><td>1) Protection start or trip
2) Binary input (manual/external triggering)</td></tr>
<tr><td>Display View</td><td>1) Relay Interrogation and Analysis Software Tools
2) Software type to be declared by the manufacturer</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.2.12</td><td>Fault Locator (For Line Protection)
The basic requirements of the relay fault location are:
<table>
<tr><th>Basic Requirements</th><th>Details</th></tr>
<tr><td>Distance to Fault Measurement</td><td>Impedance loop</td></tr>
<tr><td>Fault Distance display</td><td>1) kilometre line length (km), or
2) Percentage of line length (%)</td></tr>
<tr><td>Optional Fault Distance display</td><td>Impedance line length (ohm primary or secondary)</td></tr>
<tr><td>Other options</td><td>Zero sequence mutual coupling compensation activation for parallel double circuit lines</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
</table>

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8.2.13	Measurement/ Metering Function The basic requirements of the relay measurement/metering function are: Basic Requirements / Details Measurements under normal load conditions: 1) Load current 2) Operating voltage 3) Power Display View: 1) LCD alpha-numeric display 2) Remote/PC access via serial communication facility Other Optional Features: Able to display in primary or secondary value on system voltage and current				
8.2.15	IED Clock Circuit and Time-Stamping Capability IEDs shall be equipped with a real-time clock, with full calendar support (including leap year). Clock resolution shall be governed by IEC 60870-4, Table 7 Class TR4. Clocks shall have an accuracy of ±2ppm and shall not drift more than twenty (20) ms per hour. All IEDs that need to maintain precise time for time-stamping shall be capable of supporting IEEE 1588 time-synchronization by the Time Data Server, maintaining acceptably low drift in time between synchronizations, and time-stamping events with a precision of +/-0.5ms relative to the GPS source.				
8.2.16	Performance The IEC 61850 Conformance Test Certificate from an independent laboratory shall be provided as evidence and part of the tender submission. The laboratory shall be accredited by UCA International Users Group with ISO/IEC17025 certification with certification. The IEDs shall not show any non-conformance to IEC 61850 Parts 3, 6, 7-1, 7-2, 7-3, 7-4 & 8-1, and 9-2 (2011).				
8.3.1	Substation LAN Operation of the Substation LAN shall comply with the IEC 61850 Ethernet profile using TCP/IP. Substation LAN shall support 10/100 Mbps for bay level and 1/10/100 Mbps for process level, with consideration of whether 1Gbps is technically and economically appropriate.				
8.3.2	Communication network Cable Construction of Optical Fibre cable (OFC) Characteristics of the OFC shall be the graded index multimode optical fibre conforming to the requirement of IEC Publication No.60793-2-10, 60794-1 and DIN VDE 0888-3. The fibres shall be high grade pure or doped silica. The OFC shall withstand at least 150 kg force without breaking or damaging the fibres in the cable. The permissible bending radius shall be no greater than 20 times the outside diameter of the cable.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed of Data	Referred to Page
8.3.4	Ethernet Switch Please refer to Clause 7.3.1 Communication Network Devices- Ethernet Switch.				
8.3.5	HMI Units based on Industrial Computer The HMI unit shall conform to UL approved safety standards and be certified to FCC Class B. The statistical MTBF for the HMI unit shall be not less than 50,000 hours, when analyzed at 75% loading and 25°C. The equipment shall be capable of operating under the specified ambient conditions for indoor equipment.				
	The equipment shall be warranted to work in PEA electrical substation environments. Full repair services shall be available in THAILAND for the selected equipment.				
	All HMI hardware shall be latest available technology and shall have prior approval from the PEA before making orders by the Contractor.				
	One Personal Computer (PC), which is a 19-inch rack mounted industrial type, shall comply with the minimum requirements stated in Annex 3.				
8.3.6	Communications Gateway (CGW) The CGW shall support a data rate of 10/100/1000 Mbps Ethernet port. The CGW interfaces with the SDH WAN through a fibre optic Ethernet port, or can interface with PEA backbone network.				
	The CGW hardware shall be latest available technology and shall have prior approval from PEA before making orders by the Contractor. The CGW shall either be a PC or a Microprocessor Controller. The CGW shall be delivered at least as follows, 1) 1 GHz Intel Processor (or equivalent) 2) 1 GB SDRAM of main memory (or better) 3) 250 GB 24/7 server-type hard disk 4) Real-time clock, calendar with battery backup, and support for time-synchronization. 5) Auto-restart capability. 6) Diagnostics, on-site installation, and validation. 7) Protocol configuration 8) Security Service				
	In case that the Contractor proposes a microprocessor-based IED to work as the CGW, the proposed IED shall at least have performance equivalent to the CGW function specified above.				
8.3.7	Communication Interface Where data communication interfaces using DNP 3.0 protocol are necessary, DNP3.0 over IP shall be used over the Substation LAN.				
	A communication port between PEA SCADA control centre and fibre optic cable at the SCPS or multiplexer is RS-232, as specified in 7.2.				

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8.3.8	IED Bay Control Unit (BCU) BCU servers have data acquisition and control responsibilities within the SCPS system. In the systems to be delivered under this technical specification, they connect to traditional I/O points on the back end (e.g. status contacts, counter contacts, analog inputs, and control outputs). On the front end they are presented as IEC 61850 data models, just as though they originated from true IEC 61850-compatible sources. The data from these models shall be selectively delivered to the HMI's Local Repository according to station needs.				
	The BCU servers shall be capable of storing and executing programmable logic applications. In support of a distributed processing environment, they shall be capable of interconnecting with other BCU servers via IEC 61850 GOOSE messaging to acquire status and commands and to provide the same in return. In this way, multiple units can cooperate perform bay interlocking and automation applications. All parameters, configurations, programs, software, and process data shall be stored in non-volatile memory, along with revision control information.				
8.3.12	Printing Facility The printers shall be an A4 color laser printer.				
8.3.13	Control Circuit Requirements and Internal Wiring Conductor All BCUs and Protective relays shall be house in a dust proof cover, class IP51.				
8.3.14	Communication Port Ethernet: - For optic for 10/100 Mbps shall be provided at station level devices and bay level devices.				
8.3.16	KVM Switch The Contractor shall provide communication between a monitor, keyboard, mouse connecting to The HMI-server cabinets in a communication room, by using a KVM Switch.				

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8.4	ENGINEERING WORKSTATION AND HMI/SCPS-Server				
8.4.1	Engineering Workstation Functions The main features of the Engineering Workstation shall be: 1) Analysis of alarm, events and historical trending 2) Data Historian (Real Time Database) to gather, validate, organize & archive substation data and information from multiple distributed IEDs 3) Dedicated Engineering Interface separate from Station-operator HMI/SCPS-Server / Station Level Operator Interface (SLOI) 4) Local single central point of access of the SCPS and all IEDs within the substation 5) Management of substation configurations, settings and IEC 61850 communication services 6) Monitoring and management of communication network, primary and secondary equipment 7) Panel mounted with all components powered from substation auxiliary DC system without a DC/AC inverter 8) Power system fault information handling, analysis, evaluation & diagnostics 9) Provision of accurate, timely and trusted substation information for supporting effective decision making, engineering, operation & maintenance, fault investigation & diagnostics, and asset management, and planning processes 10) Seamless communication and interrogation with substation IEDs 11) Substation documentation management 12) Value added user specific applications developed utilising the substation information 13) Web-based remote access and applications with system access control and cyber security measures				

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<tr><td>8.4.2</td><td>Communication Network Management
The Communication Network Management application shall be provided as a management tool to commission, monitor, maintain, troubleshoot, and reconfigure the communication channels and end devices.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The Communication Network Management function shall manage and monitor the status information of the substation communication network, SCPS components together with IED communication interface and communication network devices. The operation and failure of the function shall not affect the substation communication network.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.4.3</td><td>System Access Control and Cyber Security Management

The major features of the System Access Control and Cyber Security Management function are as follows:
Table 8.1 – Security Management

<table><tr><th>Level</th><th>Access</th></tr><tr><td>Guest</td><td>• View or browse the Engineering Workstation display, but no direct access to IEDs or network devices is permitted
• View the Engineering Workstation data, but not permitted to change or delete data</td></tr><tr><td>Operator</td><td>• View or browse the Engineering Workstation display
• Able to connect, access and perform engineering tasks with IEDs or network devices
• Able to view activity log</td></tr><tr><td>System Administrator</td><td>• Able to perform as Operator level
• Able to perform additional administrative features such as resetting the activity log, and configure Engineering Workstation, IEDs and network devices</td></tr></table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The system will allow access to, and/or manipulation of the following:
Table 8.2 – User Access Functions

<table><tr><th>Feature</th><th>Description</th></tr><tr><td>Password Management</td><td>• User access password identification and verification
• Password ID management by System Administrator</td></tr><tr><td>Access Management</td><td>• User ID authentication
• User authorisation level management by System Administrator
• Minimum of three user authorisation permission levels to be provided:</td></tr><tr><td>Information and User Log and Audit Trail</td><td>• Automated user log and audit trail in terms of who & when has accessed the system, which user authorization level accessed the system, what activity was performed (e.g. create, edit, delete, etc.)
• Automated information log and audit trail in terms of how it is handled or changed, who has access to the information, and the protection level
• Data Historian record and configuration changes</td></tr><tr><td>Network Intrusion Detection System (IDS)</td><td>Monitor, detect, and respond to unauthorised activity by internal and external intrusion</td></tr><tr><td>Virus Protection</td><td>Anti-virus solution to prevent the introduction of malicious virus, codes, worm, spy ware and Trojan horse etc. on the Engineering Workstation</td></tr><tr><td>Backup and Recovery</td><td>• Create backups
• System recovering from backup
• Methodology and procedures to be addressed by Engineering Workstation developer</td></tr><tr><td>Firewalls</td><td>• Guard against external threats
• Placed at router or security perimeter of the SCPS
• Router and security firewall are supplied as part of ICT scope</td></tr></table>
Please refer to Annex 7 for details of cyber security requirements.</td><td></td><td></td><td></td><td></td></tr>
</table>

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8.4.6	SCPS System and IED Configuration Management The SCPS Systems and IED Configuration Management application shall be provided;				
	1) to manage, maintain and archive all the Substation Configuration Language (SCL) files using System and IED Configuration engineering tools as follows: a. Library of approved IED Capability Description (ICD) files b. System Specification Description (SSD) files (if available) c. Substation Configuration Description (SCD) file d. Configured IED Description (CID) files (if available) 2) to provide capability to automatically update the SCL files during installation and commissioning 3) to manage and control the revision or version of the SCL files including and comparing different versions of the configuration file databases 4) to configure the substation IEDs based on generated System Configuration Description (.SCD) file specific for the substation 5) to provide capability of distributing configuration files from single point of access to various substation IEDs and ensuring version consistency among them 6) to provide automated information log and audit trail of the configuration change or revision				
8.4.7	GOOSE Messaging Management Generic Object Oriented Substation Event (GOOSE), supports the exchange of a wide range of possible common data organized by a DATA-SET and is used to very rapidly exchange input and output data mainly of relays of trip, CB position and block, etc. The data exchange is based on publish/subscription. The IED in the same GOOSE can receive data from subscription, and also send data from publish				
8.4.8	Disturbance and Fault Information Handling The Disturbance and Fault Information Handling, application shall be provided; 1) to provide IEC 61850 disturbance recorder handling function Logical Node RDRE 2) to automatically retrieve, transfer (through IEC61850 file transfer services) or upload fault or disturbance oscillography waveform in COMTRADE file format (IEC 60255-24) from all substation IEDs. The followings are the information to be handled from the files; a. Voltage waveform b. Current waveform c. Zero sequence voltage & current d. Activated element e. Binary Input and Output Status f. CB status 3) to collect and archive the fault or disturbance COMTRADE files in Data Historian for further analysis and evaluation 4) to provide application software to perform fault or disturbance analysis and evaluation using the retrieved COMTRADE files				

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8.4.9	Engineering HMI/SCPS-Server The Engineering HMI/SCPS-Server shall be provided as a graphical user interface for engineers; 1) to access the Engineering Workstation 2) to utilise all the Engineering Workstation functions and applications, and 3) to perform the engineering-related works				
8.4.10	Web Server and Interface The Web Server shall provide user-friendly web-based graphical user interface, accessed via Internet browser; 1) to deliver secure, accurate & timely SCPS information to multiple users 2) to incorporate interactive web-based applications to the user interface 3) to allow remote access from multiple users with different authorization level				
8.4.13	Trending and Historical Analysis The Trending and Historical Analysis application shall be provided to view, trend & analyze accurate operational (real time or historical) process data with high accuracy (actual time stamp) & dependability.				
8.4.14	Automatic Fault Report Generation and Notification The Automatic Fault Report Generation and Notification application shall be provided to automatically deliver accurate, timely and trusted fault & disturbance information to the appropriate personnel.				
8.5	Power Supply power supply voltage variations within the following ranges in accordance with IEC 60870-2-1 Ed. 2. DC-Power supply: 125 V + 20% together with a transformer that will reduce the voltage to 48 V + 20% for communications equipment and PCs. HMI/SCPS-Server will be powered by an AC power supply.				
8.6	POWER DISTRIBUTION SYSTEM The Contractor shall supply power distribution cabinets, power cables, circuit protection, and other accessories needed to supply DC power to the SCPS components.				
8.8	INTEROPERABILITY AMONG DEVICES FROM DIFFERENT MANUFACTURERS, AND WITH LEGACY DEVICES/SYSTEMS Using this specification, in combination with IEC 61850-7 and IEC 61850-6, the Contractor shall make sure that interoperability between devices from different manufacturers is achievable.				
8.8.1	Interoperability among Clients and Servers The Contractor shall develop the necessary IEC 61850-IED interface from detailed IEC 61850 communications requirements provided by PEA so that interoperability at a Bay level is achievable.				

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8.8.2	Interoperability between Control Systems and Bay LAN Each BCU shall communicate with the BCUs of different manufacturers, protective relays, and other IEDs instead of, or in addition to, the IEDs communicating directly through the bay and station Ethernet Switch, to the SCPS Systems.				
10 10.1	ENGINEERING AND CONFIGURATION TOOLS PROTOCOL ANALYSER SOFTWARE The Contractor shall provide test set software for DNP 3.0 protocol and the IEC 61850 communications architecture.				
10.6	ENGINEERING TOOLS The Contractor shall be provided the engineering tools for In IEC 61850-6 part of the standard two different tools are identified in the IEC 61850 engineering process.				
	The following Engineering Tools shall be supplied for substation: 1) IED configuration tools 2) System (Substation) configuration tools 3) IED interrogation, monitoring and analysis software tools 4) Diagnostics and maintenance tools				

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<tr><td>ANNEX 10
(Rev.2-2021)
A10.1</td><td>Digital Fault Recorder (DFR) Specification

Fault Recorder
Digital Fault Recorder (DFR) shall be a microprocessor-based instrument designed for sensing, acquiring, storing and recording critical high-speed data during power system faults and disturbances. The DFR shall be integrated with Phasor Measurement Unit (PMU) functions. The DFR shall be complied with the international standards of the IEC and ANSI/IEEE C37.2-2008. Details of each function in the system shall be completely described in product’s instruction manual.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>The DFR shall be installed in substation according to relevant PEA’s criteria. The recorder shall automatically trigger and record and shall also automatically dial and transmit data to Master station at PEA’s headquarters</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Storage
The DFR shall be equipped with at least 16 GB of hard disk for data storage. The internal hard disk shall be IDE, EIDE, SCSI interfaces or solid stage memory. The total storage used for DFR shall not be less than 128 MB per Data Acquisition Unit (DAU). A hardware with better specifications will be acceptable.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Inputs
Inputs of the DFRs shall be according to substation network topology as the following:
<table><tr><th>Network topology*</th><th>Type of DFRs</th></tr><tr><td>Topology 1</td><td>Type 1 – DFR
- receive analog inputs from CTs/VTs (115 kV and 22/33 kV) and
- receive GOOSE Inputs (115 kV and 22/33 kV)</td></tr><tr><td>Topology 2</td><td>Type 1 and Type 2 – DFRs
- receive sample value inputs from CTs/VTs (115kV) and
- receive analog inputs from CTs/VTs (22/33kV) and
- receive GOOSE Inputs (115kV and 22/33kV)</td></tr><tr><td>Topology 3</td><td>Type 2 – DFR
- receive sample value inputs from CTs/VTs (115kV and 22/33kV) and
- receive GOOSE Inputs (115kV and 22/33kV)</td></tr></table>Note * Refer to clause 4.2 SYSTEM HIERACHICAL STRUCTURE</td><td></td><td></td><td></td><td></td></tr>
</table>

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	1) Sample Value (SV) inputs SV inputs of the DFR shall be from Merging Unit (MU).				
	2) Analog inputs - Current Transformer (CT) The CT secondary nominal current rating (In) shall be 1 A or 5 A, see relevant detail and drawing. A current shunt shall be able to withstand fault current up to 40xIn for 1 second and 2xIn on a continuous basis. For the 115 kV and 22/33 kV CT inputs shall be from CT's secondary terminals which are notused as a protection core. In case the contractor cannot avoid using a protection core, terminals for arc protection or backup protection are allowed to be used, but the installation detail shall be submitted to PEA for approval before installation.				
	2) Analog inputs - Voltage Transformer (VT) The VT secondary rating shall be selectable for either 66.4 V AC or 115 V AC. Signal isolators connected to this circuit shall be able to withstand two-per unit overvoltage on a continuous basis. Each analog input channel shall be completely supplied with input signal conditioning with the frequency response of DC to 2,000 Hz or better. The sampling shall be adjustable at both fast and slow scan rates in order to capture both faults and slow disturbances. At least 256 samples per cycle for fast sampling rate and at least 1 sample per cycle for slow scan sampling rate. The resolution of A/D conversion shall be at least 16 bits.				
	3) GOOSE inputs GOOSE inputs shall be from smart input/output units and protection devices via network.				
	Channels All channels completed with time synchronization shall be without reducing the quality of recording. Name and numbers of Analog/SV/GOOSE input channels shall be confirmed by PEA. See A10.8 Guidelines for input channel.				

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	Record 1) Record length shall be following (1) Fault record : Pre-fault recording interval shall be configurable between 50 and 2,500 milliseconds. Max. record length shall be configurable, at least 5 seconds. (2) Disturbance record : Pre-disturbance recording interval shall be configurable between 10 and 600 seconds. Max. record length shall be configurable, at least 10 minutes. (3) Power quality recording, all of data can be exported to general program such as Microsoft Excel or Microsoft Word, etc., with: 1. Trending data (voltage variation) 2. Voltage sag/swell, each event with voltage and current waveform shall be recorded. 3. Harmonics, with: harmonics orders : 2nd to 50th orders, or better, at 50 Hz fundamental recording : fundamental with waveform, spectrum, amplitude, phase angle and/or harmonics direction for individual orders and Total Harmonics Distortion (THD) of voltage and current, or better.				
	2) Recorded information shall be provided following data: - Substation Identification - Date, Month, Year, Hour, Minute, Second and Millisecond - Sampling Rate - Time Marker - Operation Number - All Analog, Event Channel Waveform, Sensor Operation, Time Mark - Channel Identification - Channel Zero Deflection Line - Scale Factor A line crossing each channel of the fault recorder shall be printed to mark the end of pre-fault data and the beginning of the fault data.				

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	Triggering and sensors Each sensor shall be provided with a LED target to indicate which sensor has operated; the following type of sensors shall be supplied: 1) Over current starting sensor, with: nominal current rating (In) : 1 A or 5 A, see relevant document or drawing setting range : 10 % to 300 % of In setting resolution : 5 % of In, or better accuracy : ±0.5 % of measured value ±3% of full scale ±0.5 mA, or better response time : not more than 20 milliseconds over current withstand : 40xIn for 1 second 2) Under voltage starting sensor, for sensing under voltage conditions of the buses or lines, with: setting range : 50 % to 100 % of Vn setting resolution : 5 % of Vn, or better accuracy : ±0.25% of measured value ±3% of full scale ±30 mV, or better response time : not more than 20 milliseconds 3) Frequency starting sensor, for sensing abnormal frequency conditions, the sensor shall include a transducer output that can be recorded on one of the analog channels to provide accurate cycle-by-cycle plots of frequency versus time during the disturbance, the sensor shall trigger the recorder to operate at slow sampling rate, with: setting range : 0 to 2 Hz over and under, the nominal frequency 50 Hz setting resolution : not more than 0.1 Hz accuracy : ±0.01 Hz, or better				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	4) Negative sequence voltage starting sensor, for sensing unbalance conditions, with: setting range : 1 V r.m.s. to 20 V r.m.s., adjustable setting resolution : 5% of Vn, or better accuracy : ±0.25% of measured value ±3% of full scale ±30 mV, or better response time : not more than 20 milliseconds 5) Zero sequence voltage starting sensor, for sensing earth - fault conditions, with: setting range : 1 V r.m.s. to 20 V r.m.s., adjustable setting resolution : 5% of Vn, or better. Accuracy : ±0.25% of measured value ±3% of full scale ±30 mV, or better. response time : not more than 20 milliseconds 6) Power swing starting sensor, for detecting power swing conditions in transmission line, shall be operated at slow sampling rate. 7) External start shall be provided for the fault recorder to connect with an external start signal. 8) Manual trig shall be provided for the fault recorder				
	Phasor Measurement Unit (PMU) function The Phasor Measurement Unit (PMU) to be supplied under this specification shall provide phasor and analog data at the selected periodicity. The offered PMU shall be completed in all respect so that they can be installed at the substation and can communicate with the existing of Phasor Data Concentrator (PDC) at PEA's headquarter. The necessary cables and connectors and installation hardware shall also be supplied by the contractor. The PMU shall be conformed to IEEE C37.118-2005, or later edition, and shall be designed to meet the following requirements:				

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Specification No : RSUB–010/2564 (Rev.1.0) Substation control and protection system (SCPS)

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	1) The PMU shall be designed to measure the electrical parameters in the power system frequency band of 45 – 55 Hz ensure that the impact of frequency fluctuation (45 – 55 Hz) on accuracy is within permissible limit as per prevailing standards. 2) All the measurements shall be tagged with UTC (Coordinated Universal Time). The time tagging accuracy shall be at least one micro-second. 3) The PMU output shall be in IEEE C37.118-2005, or later edition, format and shall communicate with the PDC at PEA's headquarter in the same format. The accuracy of the measurements shall be as per the IEEE C37.118-2005 standard or later edition.				
	4) The PMU shall be used to measure the following: • 3 phase positive sequence voltages as magnitude and angle (polar form) quantities. • 3 phase positive sequence currents magnitude and angle (polar form) quantities. • Frequency, Rate of change of frequency and Active and Reactive power may be derived at PMU the measured values. The PMU shall be capable of transferring the all the measured & derived quantities to PDC at PEA's headquarter along with timestamp. 5) Data of Phasor Monitoring Unit (PMU) shall be provided for every channel. 6) The PMU shall be suitable for configuring the data reporting rate of 10, 25, 50 samples per second. Actual rate shall be user selectable. 7) The PMU shall have continuous self-monitoring, diagnostic feature and capable to identify and communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC at PEA's headquarter. 8) The PMU shall communicate with PDC at PEA's headquarter on Ethernet interface thru communication ports of 10/100/1000 Base Tx for TCP/IP for streaming data in IEEE C 37.118-2005, or later edition, format.				

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	9) There shall be provision for HMI (Human Machine Interface) in PMU to perform setting changes. In addition, HMI should display the measured quantities for ease during testing. The Operation indications and time tagged events shall be available by the local HMI. Alternatively, Portable configuration device for PMU at Local/Remote end can be provided for configuring the PMU. Remote configuration facility for PMU is required.				

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	System Alarm The DFR shall be equipped with a continuous self-diagnostic which detects and alarms the particular diagnosed condition. The DFR shall detect, indicate, and alarm by LED and dry contact for the following conditions: - Operation : fault recorded operate - Fault : including CPU auto reset - Failure : including CPU fail and power fail - Service : including memory overflow and clock synchronization loss				
	Communications Between modules, fiber optic cables shall be provided for communications with redundancy between the modules that installed at separated locations together in order to operate as one system and to eliminate any possible time skew. The communicated configuration shall be included complete time synchronization and initiation of all modules from any starting sensor by means of cross triggering. The signal for cross triggering function shall not be the digital channel. The design of the communications configuration shall be submitted to PEA for approval. Plastic and iron pipe shall be used for protection of indoor and outdoor fiber optic cables respectively.				
	Communications between DFR and the local controller unit/the master station, shall be at least 100/1000 Mbps, and provided by a direct connect communication via a USB port(s). In addition to the USB port(s), the communications may be via ethernet communication by TCP/IP protocol, via self-adaptive RJ–45 interface and/or SFP Ethernet interface (optional.)				
	Synchronization The DFR shall be provided with the following time synchronizing features: 1) Synchronizing by using an external GPS clock, the GPS clock receiver and accessories shall be provided and completely installed in the cabinet per system, external antenna shall be provided and installed if necessary, power supply for GPS clock receiver shall be 125 V DC. 2) IEEE1588 or IRIG-B synchronizing shall be provided to permit synchronizing with remote station. 3) The synchronizing shall be with maximum error of 1 microsecond to meet the accuracy requirement of IEEE C37.118 standard.				

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	Clock The DFR shall be supplied with built - in calendar and clock to provide accurate date and time including month, date, year (or date, month, year), hour, minute, second and millisecond for each operation of the recorder; the clock synchronization precision shall be less than ± 300 ns. If the clock loses synchronous source after it is synchronized, the device itself shall have 24 h timing precision error less than ±100 ms. The linked fault recorded shall be time coordinated within 1 millisecond of each other. Recorded message time scale resolution shall be 0.167 ms (equivalent to the sampling rate of 600 Hz) or smaller. Maximum time scale deviation between multiple intelligent acquisition ports shall be 40 ns.				
	Security The system shall have 3 levels of password access for user, each access level shall automatically determine the access rights of the lower levels.				
A10.2	**Front panel** The DFR shall provide local man machine interface to set up the system and permit easy field modification, either through a built-in patch panel or a monitor, and a keyboard or a keypad. The local man machine interface shall be provided for programming, display status, waveform or diagnostics. The following status indicators shall be provided: 1) Healthy 2) CPU failure 3) Operation 4) Transmit and receiving 5) Loss of clock synchronize 6) Loss of power 7) Others such as Recording, Storage, Backup, Fault etc.				
A10.3	**Power supply** The DFR shall be furnished with a DC-to-DC converter to provide transient surge isolation between the station battery and DFR, main On-Off AC switch and main DC circuit breaker shall be provided, with: 1) Power supply : nominal 125 V DC ungrounded stationary battery 2) Continuous operating voltage: 110 V DC to 250 V DC				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	3) Design and protection : (a) power supply of each DC control circuits, AC power supply circuits and voltage transformer secondary supply circuits shall be completely separated and isolated and suitably protected by separate miniature circuit breakers. (b) these circuits shall have separated bus wiring between the cabinets. (c) The recorder shall be immune to damage from accidental short circuiting of the input or output DC supply. (d) The recorder shall not produce any signal, noise, or impulse which is greater than 300 millivolts peak-to-peak on the input DC supply leads.				
A10.4	**Cabinet** The DFR shall be supplied as completely wiring and completed with all accessories mounted on a standard 19-inch rack and enclosed in one or two cabinet(s), the cabinet(s) shall be furnished with channel base and designed without any permanent bottom braces, the bottom of the cabinet(s) can be opened, a floor under the channel base shall be covered by 3 mm - thick aluminium sheet and all incoming and outgoing cables shall be installed through the cover with: 1) Size : 600 - 1,000 mm depth x 800 mm - 900 mm width x 2,200 - 2,300 mm height plus a channel base 2) Colour : gray (RAL 7032) 3) Material : Not less than 3 mm - thick steel sheet 4) Wiring duct : Each cabinet shall be equipped with plastic wiring ducts, size 100 mm x 100 mm, shall be installed in vertical position through the height of the cabinet(s). 5) Grounding : The 6 mm x 25 mm copper ground bar shall be solidly bolted to the steel framework at the bottom of the cabinet(s), metallic case and grounding circuit shall be connected to the bar, solderless lugs and terminals shall be provided on the ground bar for terminating 95 mm2 copper ground cable from substation grounding system. 6) Lamp and receptacle outlet : One (1) fluorescent lamp with door operated switch one (1) receptacle outlet, single phase, 3 wire grounded type, 15 A, 250 V shall be furnished inside each cabinet with completely wiring for connection to 230 VAC, single phase, 50 Hz source. 7) Three (3) of six (6) inches ventilation fans per cabinet shall be mounted inside at the top. Their switch shall be located inside the cabinet. The power supply shall be 230 V, single-phase, 50 Hz, AC. 8) Operating temperature up to 50 °C 9) Relative humidity up to 94 %				

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A10.5	**Terminals and wiring (For analog inputs only)** The cabinet and all equipment shall be completely wired, control cable shall be shielded from electromagnetic interference (EMI) and radio frequency interference, the terminal arrangement shall group all leads for each particular function to facilitate connection to the incoming and outgoing cables, with: 1) Internal cable a) type : stranded copper conductor, PVC insulation, 750 V b) minimum cross-section : i) 1.5 mm2 for monitoring cables ii) 2.5 mm2 for VT cables iii) 2.5 mm2 for CT and DC power supply cables 2) Incoming and outgoing cable a) Type : multi-core, double insulation, stranded copper conductor, PVC sheath, copper or brass shield, PVC insulation, 750 V b) minimum cross-section : i) 2.5 mm2 for monitoring and control cables ii) 4.0 mm2 for instrument transformer cables 3) Cable colour a) DC control circuit : brown (Positive) and gray (Negative) b) voltage and current bus wire : red, yellow and blue, corresponding to phase 4) Test switches : all current and voltage inputs of the DFR shall be completely wired with test switches, shall be flexitest switches. : Type FT-1, FT, FMS-10A for voltage channels Type FMS-10F for current channels 5) Terminal block a) insulation : not less than 600 V insulating barrier between terminals b) type : i) spring loaded screw-on type for analog signal ii) short and slide link type for CT iii) slide link type for VT iv) knife switch type for digital signal c) spare : 15% of terminals shall be provided on each group of terminal block for future use. 6) Terminal lug : both ends of wires shall be terminated by compression ring type terminal lug.				

Clause No.	Clause Name	Conformance Status (C,A or N)	Standard Equipment Status (S or M)	Proposed Data	Referred to Page
	7) Designation a) Every points of the terminal block and wire shall be assigned with identical designation on each corresponding terminal block and wire, as designated in approved schematic diagram. b) All wiring shall be permanent designated at both ends by printing on designation sleeve, which resists oil, grease, acid, abrasion and chemicals, data on the designations shall be completed with the name or code of cabinet, equipment and terminal of the near terminal and far terminal in the first line and the second line respectively, colour of letter shall be black and colour of sleeve shall be white. c) Each designation on the terminal blocks shall be machine-lettered stamped or engraved with permanent ink on the removable marking strips, adhesive labels shall not be acceptable. d) Where a wire number changed, the termination shall has double designation sleeve to show both wire number. d) 10% of wire designation sleeves shall be provided for spare.				
	8) Wiring design a) Maximum voltage drop on the cables shall not exceed 5% under worst load and temperature conditions. b) Internal wiring shall be installed in wiring duct, total cross section area of cables in duct shall not exceed 70% of cross section area of duct, and external wiring shall be installed in wire way or cable trench, internal and external wiring shall be installed separately. c) All cables shall run continuously without splices or taps. d) Connections between cubicles shall be via terminal blocks. e) All switchgear auxiliary contacts, protection, control, signalling and measuring devices shall be wired to separate terminal blocks. f) Voltage and current circuits shall be wired to test blocks to enable for testing. g) Two or more wires shall not be connected in one terminal. h) All incoming and outgoing cables shall be entered the cabinet through cable grands, one cable grand / one cable.				
A10.6	**Software** The master station software package (i.e. Data-Analysis, communication software) shall be designed for multi-tasking operation, preferably using Microsoft's Windows or Linux with the latest version which supports Thai edition to allow multifunction to run simultaneously. The master station software shall be menu driven and userfriendly with the following minimum features: 1) The fault-recording-database at the master station shall be operated with the highest reliability without collapse or failure. 2) For data transmission, both the DFRs and the master station (equipment and software) shall be initialized or reset within the shortest possible time.				

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	3) It shall be capable of automatic or manual selection by user, retrieving fault data upon detection of fault or disturbance conditions at any of the remote digital fault recorder sites over TCP/IP. 4) All selected parts of a fault record can be transmitted on the entire record. 5) A printout of each record shall begin by automatic or manual selection by user. 6) The function “Automatically Poll” and “Received Calls” from the remote sites for any change of status including diagnosed problems or data shall be provided. 7) Communication link shall be able to read, download, and upload all operating parameters of any of the remote digital fault recorder sites. If any communication error occurs during up-loading and downloading parameters, the master station and the remote DFR shall roll back to use the old parameters so as to prevent improper operation. 8) A remote digital fault record shall be saved into a single file or single folder in the hard disk of the master station. A large number of remote digital fault records shall not reduce operating speed or cause malfunction of the master station. 9) Simple backup or restored backup record data with OS command. 10) It shall be able to perform File-sharing function on LAN system. 11) It shall be capable of initiating and receiving a complete test of the remote digital fault recorder and shall be capable of sending a trigger to any remote digital fault recorder to take a recording for calibration check				
	12) The application software shall include the following features as a minimum: - There shall be at least two (2) levels of sorting record data, i.e. by record name and by record date, and shall be able to open or display many records at the same time (multi-records). - It shall be able to select amplitude, time bases and waveform placement. It shall be able to place on any position and to place multiple waveforms on the same axis. Moreover, it shall be able to insert or delete any waveform on a current screen. - All waveforms which are shown on the screen and on the print preview shall be exactly the same. - It shall be able to calculate RMS value and time interval of the waveform in each cycle or in the specified range of time. - It shall be able to print the selected waveforms on one single.				

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	- It shall be able to make up a composite record of analog traces and event traces from any different digital fault recorder s in any desired combination. Such composite record shall be able to be saved as a new file. - It shall be able to automatically convert waveform record data files to both of the binary and ASCII formats of standard IEEE COMTRADE files (IEEE C37.111 – 1999 or later edition). The exported COMTRADE files must have data units specified in COMTRADE (IEEE C37.111 – 1999 or later edition) format and the data shown in actual corresponding units. - The Auto-exporting COMTRADE files shall be saved in a specified directory. The name of backup file shall be specified substation name, date and time of fault. - The COMTRADE files performed on Auto-export mode shall be named and renamed by user. - Graphic display for all analog and event channels shall include channel identification, engineering unit, scaling, date and time with resolution of one millisecond. - It shall be able to accurately calculate RMS voltage and current, peak voltage and current, sequence voltages and currents, phase angle, active and reactive powers, apparent impedance, frequency, and distance to fault. - The calculated channels function which has already been created and saved shall be available whenever a record is displayed.				
	- It shall be able to provide impedance plot on R - X diagram from selected analog channels. - For the Distance to Fault Calculation of any feeder, it shall require only three (3) voltage channels (Va, Vb, Vc, either bus voltage or line voltage) and three (3) current channels of the faulted feeder (Ia, Ib, Ic) without requirement on the neutral voltage and current channels. - It shall be able to provide calculated channels which a user can make a basic formula like summation or difference as well as be able to save, retrieve, print, display, or export. - It shall be able to accurately measure and display on the screen the instantaneous time and the magnitude values at the location of the cursor at any point on the trace waveform. - Time base expansion or compression shall be provided for graphic display. - Harmonic analysis (up to 13th harmonic) using FFT of a selected trace waveform shall be provided.				
	13) For the startup, all application software and all setting parameters shall be supplied. 14) Both software & hardware (for example: hard lock, etc.) shall be well-prepared for the system extension in the future.				

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<tr><td>A10.7</td><td>Service and Training
Start-up supervisors shall be provided to assure that the DFR has been properly setup by Contractor. Supervisors shall be able to set up the master station so that it can retrieve all data and parameters to and from the DFR which is located at the substation. In addition, an on-site training and the installation of software at the master station, the use of application software, the operation and maintenance of the systems shall be provided.</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>Each DFR shall be complete with:
1) Software and user manual
2) Accessories according to manufacturer’s design and auxiliary equipment necessary to complete</td><td></td><td></td><td></td><td></td></tr>
<tr><td>A10.8</td><td>Guidelines for input channel
1) 115 kV Voltage level
<table>
<tr><th colspan="4">SV/Analog Inputs</th></tr>
<tr><th colspan="2">Voltage Input[1]</th><th colspan="2">Current Input[1]</th></tr>
<tr><td>- VT Bus</td><td>Import 3 phase of all Bus</td><td>- CT Line</td><td>Import 3 phase of all Line</td></tr>
<tr><td></td><td></td><td>- CT Coupling Bus</td><td>Import 3 phase</td></tr>
<tr><td>- VT Line[2]</td><td>Import 3 phase of all Line</td><td>- CT High Side Transformer</td><td>Import 3 phase</td></tr>
<tr><td></td><td></td><td>- CT Low Side Transformer</td><td>Import 3 phase</td></tr>
<tr><td></td><td></td><td>- CT Neutral Transformer</td><td></td></tr>
<tr><td colspan="4">Note: [1] For hardwire input from VT/CT shall be provide test switch at DFR panel.
[2] If VT line are not installed at all 3 phases, shall be import the phase used for Sync.</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>
<table>
<tr><th colspan="3">GOOSE Inputs</th></tr>
<tr><th>Circuit Breaker</th><th>Bus Protection</th><th>Line Protection</th></tr>
<tr><td>- Circuit Breaker Contact (52a & 52b) All CB</td><td>- Relay Start
- Relay Trip
- Relay Function Start</td><td>- Relay Start
- Relay Trip
- Relay Function Start</td></tr>
<tr><td>- 86BF All CB</td><td>- Cut off (if any)</td><td>- Auto Recloser Operate
- Communication Fail (If any)
- All Cut off (If any)</td></tr>
<tr><th colspan="3">Disconnecting Switch</th></tr>
<tr><td colspan="3">- Disconnecting Switch Contact All DS</td></tr>
</table></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>2) 22 kV Voltage level
<table>
<tr><th colspan="4">SV/Analog Inputs</th></tr>
<tr><th colspan="2">Voltage[1]</th><th colspan="2">Current[1]</th></tr>
<tr><td>- VT Bus</td><td>Import 3 phase of all Bus</td><td>- CT coupling Bus</td><td>Import 3 phase</td></tr>
<tr><td>- VT Line</td><td>Import 3 phase of all outgoing that have VSPP connecting (If any)</td><td>- CT Line</td><td>Import 3 phase of all outgoing and capacitor feeder</td></tr>
<tr><td colspan="4">Note: [1] For hardwire input from VT/CT shall be provide test switch at DFR panel.</td></tr>
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<tr><td>- 86BF All CB</td><td>- Cut off (if any)</td><td>- Auto Recloser Operate
- All Cut off (if any)</td></tr>
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A10.9	Guidelines for setting trigger				

General setting	- Sampling rate:	256 samples/cycle
	- Pre fault time:	150 milliseconds
	- Post fault time:	2 seconds
	- Max Record time:	5 seconds
SV/Analog setting	Voltage:	
	- Over Voltage:	110 % of ($115/\sqrt{3}$ or $22\sqrt{3}$)
	- Under Voltage:	85% of ($115/\sqrt{3}$ or $22\sqrt{3}$)
	- Frequency high:	50.5 Hz
	- Frequency low:	49.5 Hz
	Current:	
	- Over Current:	120% of CT rated
	- Current sudden change:	8% of CT rated (If any)
GOOSE setting	- Circuit Breaker Status Open (Contact Open 52b)	
	- Bus Lockout Relay Trip (86B) (All contacts send to trip all trip coil)	
	- Transformer Lockout Relay Trip (86T) (All contacts send to trip all trip coil)	
	- Line Main Protection 1 Trip (All contacts send to trip all trip coil)	
	- Line Main Protection 2 Trip (All contacts send to trip all trip coil)	
	- Feeder Protection Trip (All contacts send to trip all trip coil)	
	- Auto Reclose Operate (Use contact to close circuit breaker)	