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January 22, 2009

04-SF-80-12.7/13.2
04-0120S4

Addendum No. 2

Dear Contractor:

This addendum is being issued to the contract for CONSTRUCTION ON STATE HIGHWAY IN THE CITY AND COUNTY OF SAN FRANCISCO FROM THE YERBA BUENA TUNNEL TO 0.6 KM EAST OF YERBA BUENA TUNNEL.

Submit bids for this work with the understanding and full consideration of this addendum. The revisions declared in this addendum are an essential part of the contract.

Bids for this work will be opened on July 14, 2009.

This addendum is being issued to revise the Project Plans, the Notice to Bidders and Special Provisions, the Bid book, and provide a copy of the Information Handout.

Project Plan Sheets 1, 17, 76, 298, 551, 552, 553, 572, 574, 620, 627, 706, 759, 760, 763, 764, 765, 773, 777 are revised. A half-sized copy of the revised sheets are attached for substitution for the like-numbered sheets.

Project Plan Sheets 738A, 738B, 738C, 783A, 783B, 783C are added. A half-sized copy of the added sheets are attached for addition to the project plans.

In the Special Provisions, Section "NOTICE TO BIDDERS", the eighth paragraph is revised as follows:

"Complete the work within the number of working days bid. Do not bid more than 900 working days for the Designated Portion of Work 1."

In the Special Provisions, Section "NOTICE TO BIDDERS", the ninth paragraph is revised as follows:

"The estimated cost of the project is \$167,000,000."

In the Special Provisions, Section 4, "BEGINNING OF WORK, TIME OF COMPLETION, AND LIQUIDATED DAMAGES", is revised as attached.

In the Special Provisions, Section 5-1.07, "SUPPLEMENTAL PROJECT INFORMATION," subsection "INFORMATION HANDOUT," subsection "Geotechnical Information Handout," Item "9" is added as follows:

"9. Supplemental Geotechnical Data for Design and Construction of Foundations in Eastern Tunnel Approach Slopes, SFOBB, Yerba Buena Island."

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In the Special Provisions, Section 5-1.11," AREAS FOR CONTRACTOR'S USE," is revised as attached.

In the Special Provisions, Section 5-1.335," INDEMNIFICATION," is added as attached.

In the Special Provisions, Section 10-1.28," EMERGENCY ACCESS ROAD CONTINGENCY PLAN," is revised as attached.

In the Special Provisions, Section 10-1.41," EXISTING HIGHWAY FACILITIES," subsection "PREPARE CONCRETE BRIDGE DECK SURFACE," is revised as attached.

In the Special Provisions, Section 10-1.445," WATERING," is added as attached.

In the Special Provisions, Section 10-1.59," CONCRETE STRUCTURES," the following paragraph is added after the fifth paragraph.

"Surfaces to receive Class 1 finish in conformance with section 51-1.18B," Class 1 Surface Finish," of the Standard Specifications shall include undersurfaces of box girder spans."

In the Special Provisions, Section 10-1.59," CONCRETE STRUCTURES," subsection "MEASUREMENT AND PAYMENT", the following paragraph is added after the eighth paragraph.

"Full compensation for producing Class 1 surface finish on the undersurfaces of box girder spans shall be considered as included in the contract price paid per cubic meter for structural concrete (bidge) and no additional compensation will be allowed therefor."

In the Special Provisions, Section 10-1.70," POLYESTER CONCRETE OVERLAY (19 mm, 50mm)," is revised as attached.

In the Special Provisions, Section 10-1.108," GAS PIPE," is revised as attached.

In the Special Provisions, Section 10-3.16," SUPERVISORY CONTROL AND DATA ACQUISITION REMOTE TERMINAL UNIT SYSTEM," is revised as attached.

In the Bid book, in the "Bid Item List," Items 48 and 149 are revised, Items 184, 185 and 186 are added and Item 183 is deleted as attached.

To Bid book holders:

Replace pages 5, 10 and 12 of the "Bid Item List" in the Bid book with the attached revised pages 5, 10 and 12 of the Bid Item List. The revised Bid Item List is to be used in the bid.

Attached is a copy of the Information Handout "Supplemental Geotechnical Data for Design and Construction of Foundations in Eastern Tunnel Approach Slopes, SFOBB, Yerba Buena Island".

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Inquiries or questions in regard to this addendum must be communicated as a bidder inquiry and must be made as noted in the Notice to Bidders section of the Notice to Bidders and Special Provisions.

Indicate receipt of this addendum by filling in the number of this addendum in the space provided on the signature page of the Bid book.

Submit bids in the Bid book you now possess. Holders who have already mailed their book will be contacted to arrange for the return of their book.

Inform subcontractors and suppliers as necessary.

This office is sending this addendum by GSO overnight mail to all book holders to ensure that each receives it. A copy of this addendum is available for the Contractors' use on the Web site:

http://www.dot.ca.gov/hq/esc/oe/weekly_ads/addendum_page.html

If you are not a Bid book holder, but request a book to bid on this project, you must comply with the requirements of this letter before submitting your bid.

Sincerely,

ORIGINAL SIGNED BY

ROBERT E. TRAVIS, Chief
Office of Plans, Specifications & Estimates
Division of Engineering Services - Office Engineer

Attachments

SECTION 4. BEGINNING OF WORK, TIME OF COMPLETION, AND LIQUIDATED DAMAGES

The second through fourth paragraphs, inclusive, and the first sentence of the fifth paragraph of Section 8-1.06, "Time of Completion," of the Standard Specifications shall not apply. A working day is defined as any day, with no exceptions.

Do not start construction operations at the job site until Area PR is made available to the Contractor as specified in "Areas for Contractor's Use," of these special provisions unless otherwise approved by the Engineer.

You may start work at the job site before the availability of Area PR if the Engineer authorizes it in writing. The Department grants a time extension if a delay is beyond your control and prevents you from starting work at the job site should the areas for contractor's use not be available as specified in "Contractor's Area Use," of these special provisions.

Do not start work at the job site, except for measuring controlling field dimensions and locating utilities, until the Engineer approves your submittal for:

1. Baseline Progress Schedule (Critical Path Method)
2. Storm Water Pollution Prevention Plan (SWPPP)
3. Notification of Dispute Review Board (DRB) nominee and disclosure statement
4. Working Drawing Submittal as specified in "Working Drawing Submittal," of these special provisions:
 - a. All falsework, shoring, and excavation plans
 - b. All fabrication working drawings
 - c. All concrete mix designs
 - d. All integrated shop drawings
 - e. All pile related submittals including fabrication working drawings

Designated Portion of Work 1: All structural, electrical, mechanical, underground work required to complete westbound and eastbound Route 80 structures to the construction joint shown on the plans. The following items are excluded from the work required to complete designated portion of work 1:

- a. Hinge W7LA
- b. Hinge W6RB
- c. Route 80 on-ramp spine extension, concrete barriers, lighting, roadside signs and overhead sign structures, and the bike path structure.

The designated portion of work 1 shall be diligently prosecuted to completion before the expiration of number of days bid starting on the 15th day after contract approval.

Bids in which the number of working days bid for completion of the Designated portion of work 1 exceed **900 days** will be considered non-responsive and will be rejected.

Liquidated damages are \$50,000 per day starting on the 1st day after exceeding the above number of working days bid for completion of the designated portion of work 1

Designated Portion of Work 2: Ready for traffic on westbound Route 80, westbound on-ramp, and westbound off-ramp (Left) structures.

The work includes but is not limited to the required completion of the westbound Route 80, westbound on-ramp, and westbound off-ramp; structures and roadway, electrical and lighting system, roadside signs and overhead sign structures, call boxes, and mechanical system.

The designated work shall be diligently prosecuted to completion before the expiration of 180 working days after completion of the designated work portion 1.

Liquidated damages are \$100,000 per day starting on the 1st day after exceeding the above specified number of working days for completion of the designated portion of work 2.

Designated Portion of Work 3: Ready for traffic on eastbound Route 80 and temporary eastbound on-ramp structure and roadway.

The work includes but is not limited to the required completion of the eastbound Route 80 and temporary eastbound on-ramp; structures and roadway, electrical and lighting system, roadside signs and overhead sign structures, call boxes, and mechanical system.

The designated work shall be diligently prosecuted to completion before the expiration of 180 working days after completion of the designated portion of work 2.

Liquidated damages are \$100,000 per day starting on the 1st day after exceeding the above specified number of working days for completion of the designated portion of work 3.

Designated Portion of Work 4: Complete all remaining work.

The designated work shall be diligently prosecuted to completion before the expiration of 60 working days after completion of the designated portion of work 3.

Liquidated damages are \$13,400 per day starting on the 1st day after exceeding the above specified number of working days for completion of the designated portion of work 4.

Should two or more liquidated damages accrue concurrently, no more than \$100,000 per day will be assessed.

It is anticipated that water will be available in sufficient quantities for the prosecution of the work. However, water shortages may occur during the life of the contract. Arrangements or commitments obtained by the Department are not a part of the contract. It is expressly understood and agreed that the Department assumes no responsibility to the bidder or Contractor whatsoever in respect to the arrangements made with the source. The Contractor shall assume all risks in connection with the use of the source and the terms upon which the use shall be made. There is no warranty or guaranty, either expressed or implied, to the quantity of water that can be obtained from the source. If the Department has compiled "Materials Information", as referred to in "Watering" of these special provisions, the bidder or Contractor is cautioned to make independent investigations and obtain the commitments or allocations as the bidder or Contractor deems necessary to verify the quantity of water available. The Contractor shall make arrangements or obtain commitments or allocations necessary to provide water for the project.

During the progress of the work, if water becomes unavailable or unavailable in the quantities needed for prosecution of the work, the unavailability of water will be considered a "shortage of materials" in conformance with the provisions in Section 8-1.07, "Liquidated Damages," of the Standard Specifications except for compensation. The Contractor will be granted an extension of time and will not be assessed with liquidated damages for any portion of the delay in completion of the work beyond the time shown above for the completion of the work caused by the unavailability of water, provided the Contractor notifies the Engineer and furnishes proof of the "shortage of materials" as required in the third and fourth paragraphs in Section 8-1.07, "Liquidated Damages," of the Standard Specifications. If the Contractor sustains delay costs or damages which could not have been avoided by the judicious handling of forces, equipment and plant, there shall be paid to the Contractor the amount the Engineer may find to be a fair and reasonable compensation for the part of the Contractor's actual loss, as, in the opinion of the Engineer, was unavoidable, determined in the same manner as provided for right of way delays in Section 8-1.09, "Right of Way Delays," of the Standard Specifications. The Contractor shall be entitled to no other compensation for such delay. The provisions in Section 5-1.116, "Differing Site Conditions," of the Standard Specifications shall not apply to the unavailability of water.

5-1.11 AREAS FOR CONTRACTOR'S USE

Attention is directed to the requirements specified in Section 7-1.19, "Rights in Land and Improvements," of the Standard Specifications, plans and these special provisions.

The highway right of way shall be used only for purposes that are necessary to perform the required work. The Contractor shall not occupy the right of way, or allow others to occupy the right of way, for purposes which are not necessary to perform the required work.

The Contractor's attention is directed to "Cooperation," of these special provisions, and the Contractor shall use only the designated areas for Contractor's use as specified in this section, and as shown on the plans and as follows:

1. **Area PR:** is not available for the 04-0120S4 Contractor's use until May, 2010 unless otherwise approved by the Engineer. After said date, Contractor shall permit access by others if directed by the Engineer.
2. **Area FP:** is not available for the 04-0120S4 Contractor's use until May, 2010 unless otherwise approved by the Engineer. After said date, Contractor shall permit access by others if directed by the Engineer.

No area is available within the contract limits for the exclusive use of the Contractor. However, temporary storage of equipment and materials on State property may be arranged with the Engineer, subject to the prior demands of State maintenance forces and to other contract requirements. Use of the Contractor's work areas and other State-owned property shall be at the Contractor's own risk. The State shall not be held liable for damage to or loss of materials or equipment located within these areas.

Toll plaza parking lots shall not be used for the Contractor's employees private vehicles and the Contractor's equipment and vehicles.

The Contractor shall remove the equipment, materials, and rubbish from the work areas and other State-owned property which the Contractor occupies and shall leave the areas in a presentable condition, in conformance with the provisions in Section 4-1.02, "Final Cleaning Up," of the Standard Specifications.

The Contractor shall secure, at the Contractor's own expense, areas required for storage of plant, equipment, and materials, or for other purposes if sufficient area is not available to the Contractor within the contract limits.

5-1.335 INDEMNIFICATION

"The Contractor shall be responsible for any liability imposed by law and for injuries to or death of any person including, but not limited to, workers and the public or damage to property, and shall indemnify and save harmless T.Y. Lin International / Moffatt & Nichol Engineers, a Joint Venture and its consultants and subconsultants, in the same manner and to the same extent conforming to the provisions in Section 7-1.12, "Indemnification and Insurance," of the Standard Specifications, for the protection of the State of California and all officers and employees thereof connected with the work. Contractor's liability policies shall be required to name T.Y. Lin International / Moffatt & Nichol Engineers, a Joint Venture, their respective affiliates, parent or affiliated corporations, directors, officers, partners, representatives, employees, consultants, subconsultants and agents, as additional insureds to the extent that the State is named as an additional insured under the Standard Specifications and these Special Provisions with respect to the liability arising from the activities of the Contractor. Certificates of insurance shall provide thirty (30) days advance written notice of cancellation or nonrenewal and shall clearly specify the Contractor's contract number under which services are provided to the State and the name of the project. Certificates of insurance and endorsements as required herein shall be provided by Contractor's insurers to the following address:

T.Y. Lin International / Moffatt & Nicole Engineers, A Joint Venture
c/o Dealey, Renton & Associates
P.O. Box 12675
Oakland, CA 94604-2675"

10-1.28 EMERGENCY ACCCES ROAD CONTINGENCY PLAN

Attention is directed to the local streets, Treasure Island Road and Southgate Road which serve local traffic between the Treasure Island and Yerba Buena Island.

Attention is also directed to the closure of Southgate Road during the construction period of the contract. Should the Treasure Island Road Viaduct become unusable due to instability or major damage, a minimum of one unpaved traffic lane, at the vicinity of Southgate Road for use by public traffic will be required within one hour.

The Contractor shall stage the work such that the contingency plan to provide an emergency access road is possible with minimal impact to the work within one hour at any time. Should the viaduct become unusable, the Contractor will receive a written notice to implement the contingency plan from the Engineer. Minimal impact to the work as used herein is defined to mean that major operations such as excavations and concrete pours are not prevented from continuing by local traffic using the emergency access road.

The Contractor shall prepare a written contingency plan to provide the emergency access road through the work during all phases of the work. The plan shall show anticipated traffic routes, variations as the work progresses, and the equipment, materials, and general work necessary to implement the emergency access road. The Contractor shall submit the contingency plan in conformance with "Working Drawings," of these special provisions for the Engineer's approval 30 working days prior to the start of any closure of the portion of Southgate road within the contract limits. The Contractor will not be required to implement any part of the plan except as directed by the Engineer.

The emergency access road may be an unpaved roadway and shall conform to the following requirements:

1. A minimum 3.6-meter wide traffic lane
2. A minimum vertical clearance of 3.7-meter.
3. A finished profile grade of not to exceed 10%.
4. Temporary railing (Type K) along the edge of traveled way to shield fixed objects and drop offs

Full compensation for staging the work and providing a contingency plan for the emergency access road through the work within one hour shall be considered as included in the prices paid for the various contract items of work and no separate payment will be made therefor.

Should any portion of the plan be implemented at the written direction of the Engineer, such work will be paid for as extra work as provided in Section 4-1.03D "Extra Work" of the Standard Specifications.

If, in the opinion of the Engineer, completion of the work is delayed or interfered with due to the implementation of the emergency access road, an extension of time will be granted, in the same manner as provided for in Section 8-1.09, "Right of Way Delays," of the Standard Specifications. No additional compensation will be provided to the Contractor.

PREPARE CONCRETE BRIDGE DECK SURFACE

This work shall consist of cleaning the portland cement concrete deck surface on portions of the Self Anchored Suspension (SAS) structures and on portions of the existing viaduct replacement structure adjacent to the westbound transition structure by using steel shot-blasting and blowing clean the deck surface, as shown on the plans and as described in these special provisions. Asphalt concrete surfacing shall be removed at the existing viaduct replacement structure adjacent to the westbound transition structure in conformance with these special provisions.

The Contractor shall submit to the Engineer for review plans and procedures for protecting the seismic joints in place during deck cleaning operations.

All laitance and surface contaminants including, but not limited to, rust, oil, paint, joint material, curing compound, and other foreign material shall be cleaned from the surface of the existing concrete deck.

If the surface becomes contaminated at any time prior to placing the primer for the overlay, the surface shall be cleaned by abrasive blasting.

Equipment shall be fitted with suitable traps, filters, drip pans, or other devices, as necessary, to prevent oil or other deleterious material from being deposited on the deck.

Equipment or procedures that leave fractured aggregate or otherwise damage the concrete surface which is to remain shall not be used.

Remove Asphalt Concrete Surfacing

Prior to deck cleaning operations, existing asphalt concrete surfacing shall be removed to the top of existing portland cement concrete slab at bridge decks as shown on the plans and as described in these special provisions.

The Contractor shall verify the depth of asphalt concrete surfacing at a minimum of one location on each shoulder and one location in the traveled way every 30 meters.

The method of removal shall be selected by the Contractor. Equipment or procedures that damage the remaining concrete surface, as determined by the Engineer, shall not be used.

Cold milling equipment may be used to remove asphalt concrete surfacing, except that at least 13 mm of asphalt concrete surfacing shall remain on the deck after the cold milling operation. Removal of the remaining 13 mm of asphalt concrete surfacing shall be performed by other means as selected by the Contractor.

If the Contractor elects to use cold milling equipment, the cold milling equipment shall have the capability to 1) remove concrete a minimum depth of 6 mm, 2) provide a surface relief of no more than 6 mm, and 3) maintain a 4-mm grade tolerance; and shall have the following features:

- A. 3 or 4 riding tracks.
- B. An automatic grade control system with an electronic averaging system having 3 sensors on each side of the equipment.
- C. A conveyor system that leaves no debris on the bridge.
- D. A drum that operates in an up-milling direction.
- E. Bullet tooth tools with tungsten carbide steel cutting tips.
- F. A 16-mm maximum tool spacing.
- G. A maximum operating mass of 25400 kg.

The Contractor shall select which sensors are activated during the milling operation to produce the profile required as shown on the plans.

The cold milling equipment shall have a complete set of new tooth tools at the beginning of the job, and the tooth tools shall be replaced as necessary to perform the work satisfactorily.

The Contractor shall provide personnel on each side of the milling drum to monitor the milling operation and maintain radio communication with the operator at all times during the milling operation.

All removed materials shall become the property of the Contractor and shall be disposed of in conformance with the provisions in Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

Preparing concrete bridge deck surface will be measured by the square meter of surface which is prepared to receive the overlay, based on dimensions shown on the plans.

The contract price paid per square meter for prepare concrete bridge deck surface shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in preparing the concrete bridge deck surface, including removing asphalt concrete surfacing as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.445 WATERING

Developing a water supply and applying watering shall conform to the provisions in Section 17, "Watering," of the Standard Specifications and these special provisions.

Attention is directed to "Beginning of Work, Time of Completion and Liquidated Damages" of these special provisions regarding availability of water.

10-1.70 POLYESTER CONCRETE OVERLAY (19 mm, 50 mm)

This work shall include furnishing, testing, and application of methacrylate resin prime coat and polyester concrete overlay on portions of the Self Anchored Suspension (SAS) structures and on a portion of the existing viaduct replacement structure adjacent to the westbound transition structure as shown on the plans and as specified in these special provisions.

Polyester concrete shall be colored to match the adjacent existing surfaces as approved by the Engineer.

Before starting deck overlay work, the Contractor shall submit plans in conformance with "Working Drawings" of these special provisions for the following:

- A. Public safety plan for the use of methacrylate resin and polyester concrete
- B. Placement plan for the construction operation

The plans shall identify materials, equipment, and methods to be used.

The public safety plan for the use of methacrylate resin and polyester concrete shall include details for the following:

- A. Shipping
- B. Storage
- C. Handling
- D. Disposal of residual methacrylate resin, polyester concrete, and the containers

When overlay work is to be conducted within 31 meters of a residence, business, or public space, including sidewalks under a structure, the Contractor shall notify the public at least 7 days before starting work and monitor airborne emissions during the work. Public notification and monitoring of airborne emissions shall conform to the following:

- A. The public safety plan shall include a copy of the notification letter and a list of addresses and locations where the letter will be delivered and posted. The letter shall state the overlay work locations, dates, times, and what to expect. The letter shall be delivered to each residence and each business within 31 meters of the overlay work. The letter shall be delivered to local fire and police responders, and it shall be posted at the job site.
- B. The public safety plan shall include an airborne emissions monitoring plan prepared by a certified industrial hygienist and a copy of the hygienist's certification. Airborne emissions shall be monitored at a minimum of 4 points including the point of mixing, the point of application, and the point of nearest public contact, as determined by the Engineer. At the completion of overlay work, a report by the certified industrial hygienist with results of the airborne emissions monitoring plan shall be submitted to the Engineer.

The placement plan for construction shall include the following:

- A. Schedule of overlay work for each bridge. The schedule shall be consistent with "Maintaining Traffic" of these special provisions and shall include time for the Engineer to perform California Test 342.
- B. Methods and materials to be used, including the following:
 - 1. Description of equipment for applying the methacrylate resin
 - 2. Description of equipment for measuring, mixing, placing, and finishing the polyester concrete overlay
 - 3. Cure time for the polyester concrete
 - 4. Description of equipment for applying the sand
- C. Methods of protection for seismic joint at the hinges during polyester concrete overlay placement operations

If the measures proposed in the safety plan are inadequate to provide for public safety associated with the use of methacrylate resin and polyester concrete, the Engineer will reject the plan and direct the Contractor to revise the plan. Directions for revisions will be in writing and include detailed comments. The Engineer will notify the Contractor of the approval or rejection of a submitted or revised plan within 15 days of receipt of that plan.

In the event the Engineer fails to complete the review within the time allowed, and if, in the opinion of the Engineer, completion of the work is delayed or interfered with by reason of the Engineer's delay in completing the review, the Contractor will be compensated for any resulting loss, and an extension of time will be granted, in the same manner as provided for in Section 8-1.09, "Right of Way Delays," of the Standard Specifications.

For concrete decks that are existing before the start of the project, the smoothness of existing decks that are to be covered with polyester concrete overlay will be tested by the Engineer with a bridge profilograph. Changing the smoothness of these existing bridge decks will be as directed by the Engineer and will be paid for as extra work as provided in Section 4-1.03D, "Extra Work," of the Standard Specifications.

Before beginning polyester deck overlay work, the cast-in-place portland cement concrete deck surface shall be prepared as specified in "Prepare Concrete Bridge Deck Surface," of these special provisions.

Completed polyester concrete deck overlay shall conform to the provisions in Section 51-1.17, "Finishing Bridge Decks," of the Standard Specifications and these special provisions.

MATERIALS

Before using methacrylate resin and polyester concrete, a Material Safety Data Sheet shall be submitted for each shipment of methacrylate and polyester resins.

Before placing polyester concrete, the deck shall receive a methacrylate resin prime coat. Methacrylate resin shall be low odor, wax free, and have a high molecular weight. Before adding initiator, the resin shall have a maximum volatile content of 30 percent when tested in conformance with the requirements in ASTM Designation: D 2369, and shall conform to the following:

METHACRYLATE RESIN PRIME COAT		
PROPERTY	REQUIREMENT	TEST METHOD
* Viscosity	0.025 Pa s , maximum, (Brookfield RVT with UL adaptor, 50 RPM at 25°C)	ASTM D 2196
* Specific Gravity	0.90 minimum, at 25°C	ASTM D 1475
* Flash Point	82°C, minimum	ASTM D 3278
* Vapor Pressure	1.0 mm Hg, maximum, at 25°C	ASTM D 323
PCC Saturated Surface-Dry Bond Strength	3.5 MPa, minimum at 24 hours and 21±1°C	California Test 551
* Test shall be performed before adding initiator.		

Polyester concrete shall consist of polyester resin binder and dry aggregate. The resin shall be an unsaturated isophthalic polyester-styrene co-polymer conforming to the following:

POLYESTER RESIN BINDER		
PROPERTY	REQUIREMENT	TEST METHOD
* Viscosity	0.075 to 0.200 Pa s (RVT, No. 1 Spindle, 20 RPM at 25°C	ASTM D 2196
* Specific Gravity	0.075 to 0.200 Pa s (RVT, No. 1 Spindle, 20 RPM at 25°C	ASTM D 1475
Elongation	35 percent, minimum Type I at 11.5 mm/min. Thickness = 6.5 ± 1 mm	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
Tensile Strength	17.5 MPa, minimum Type I at 11.5 mm/min. Thickness = 6.5 ± 1 mm	ASTM D 638
	Sample Conditioning: 18/25/50 + 5/70	ASTM D 618
* Styrene Content	40 percent to 50 percent by mass	ASTM D 2369
Silane Coupler	1.0 percent, minimum (by mass of polyester styrene resin)	
PCC Saturated Surface-Dry Bond Strength	3.5 MPa, minimum at 24 hours and 21 ± 1°C	California Test 551
* Static Volatile Emission	60 gram per square meter, loss, maximum	South Coast Air Quality Management District, Standard Method
* Test shall be performed before adding initiator.		

The silane coupler shall be an organosilane ester, gammamethacryloxypropyltrimethoxysilane. The promoter shall be compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators.

Aggregate for polyester concrete shall conform to the provisions in Section 90-2.02, "Aggregates," of the Standard Specifications and either of the following combined aggregate gradings:

COMBINED AGGREGATE		
Sieve Size	Percentage Passing	
	9.5 mm Max.	4.75 mm Max.
12.5 mm	100	100
9.5 mm	83 - 100	100
4.75 mm	65 - 82	62 - 85
2.36 mm	45 - 64	45 - 67
1.18 mm	27 - 48	29 - 50
600 µm	12 - 30	16 - 36
300 µm	6 - 17	5 - 20
150 µm	0 - 7	0 - 7
75 µm	0 - 3	0 - 3

Aggregate retained on the 2.36 mm sieve shall have a maximum of 45 percent crushed particles when tested in conformance with California Test 205. Fine aggregate shall consist of natural sand.

The polyester resin binder in the concrete shall be approximately 12 percent by weight of the dry aggregate; the exact percentage will be determined by the Engineer.

The average of coarse and fine aggregate absorption shall not exceed one percent as determined by California Tests 206 and 207.

At the time of mixing with the resin, the moisture content of the aggregate, as determined by California Test 226, shall not exceed one half of the aggregate absorption.

TESTING

The Contractor shall allow 20 days for sampling and testing by the Engineer of the methacrylate and polyester resins before proposed use. If bulk resin is to be used, the Contractor shall notify the Engineer in writing at least 15 days before the delivery of the bulk resin to the job site. Bulk resin is any resin stored in containers in excess of 209 liters.

Before constructing the overlays of the thicknesses listed in the Engineer's Estimate, one or more trial overlays for each thickness shall be placed on a previously constructed concrete base to determine the initial set time and to demonstrate the effectiveness of the methacrylate resin primecoat and also the polyester concrete mixing, placing, and finishing equipment. Trial overlays shall also demonstrate the color matching to the adjacent existing surface. Each trial overlay shall be at least 3.6 m wide, at least 1.8 m long, and the same thickness as the overlay to be constructed. The trial overlay areas shall be within the project limits and at a location approved by the Engineer. Weather and pavement conditions during the test work shall be similar to those expected on the deck for production work. Equipment used for testing shall be similar to those used for deck overlay production work.

The trial overlay approved by the Engineer shall be used as the standard of determining acceptability of color for the polyester concrete surface.

All materials used in the trial overlays, including the concrete base, shall become the property of the Contractor and shall be removed and disposed of in conformance with the provisions in Section 7-1.13, "Disposal of Material Outside the Right of Way," of the Standard Specifications.

CONSTRUCTION

Equipment shall be fitted with suitable traps, filters, drip pans, or other devices as necessary to prevent oil or other deleterious material from being deposited on the deck.

When magnesium phosphate concrete is placed before the deck overlay, the prime coat shall not be placed on this concrete until at least 72 hours after final set.

When modified high alumina based concrete is placed before the deck overlay, the prime coat shall not be placed on this concrete until at least 30 minutes after final set.

Expansion joints shall be adequately protected before overlaying as described in the approved placement plan.

Before applying the methacrylate resin prime coat, the area to receive the prime coat shall be dry and blown clean by compressed air to remove accumulated dust and any other loose material. The prepared surface temperature shall be at least 10°C and not more than 38°C, and the relative humidity less than 85 percent when the prime coat is applied.

The prime coat shall be uniformly applied to completely cover the surface to receive the polyester concrete. The rate of spread shall be approximately 2.2 square meters per liter.

Immediately after the prime coat has been applied, the polyester concrete overlay shall be placed.

Polyester concrete shall be mixed in mechanically operated mixers. The resin binder shall be initiated and thoroughly blended just before mixing with aggregate. The polyester concrete shall be mixed for a minimum of 2 minutes before placing. Mixer size shall be limited to a 0.25-cubic meter capacity, unless approved by the Engineer.

A continuous mixer, employing an auger screw/chute device, may be approved for use by the Engineer contingent on a demonstration that the device can consistently produce a satisfactory product. The continuous mixer shall (1) be equipped with a metering device that automatically measures and records the aggregate volumes and the corresponding resin volumes, and (2) have a readout gage, visible to the Engineer at all times, that displays the volumes being recorded. The volumes shall be recorded at no greater than 5 minute intervals along with the time and date of each recording. A printout of the recordings shall be furnished to the Engineer at the end of each workshift.

The amount of initiator used in polyester concrete shall be sufficient to produce an initial set time between 30 minutes and 120 minutes during placement. The initial set time will be determined by using an initial-setting time Gillmore needle in conformance with the requirements in ASTM Designation: C 266. Accelerators or inhibitors may be required to achieve proper set times and shall be used as recommended by the resin supplier.

Polyester concrete shall be placed before gelling and within 15 minutes following addition of initiator, whichever occurs first. Polyester concrete that is not placed within this time shall be discarded.

The finishing equipment shall be used to strike off the polyester concrete to the established grade and cross section. Finishing equipment shall be fitted with vibrators or other mechanisms capable of consolidating the polyester concrete to the required compaction.

The polyester concrete shall be consolidated to a relative compaction of not less than 97 percent in conformance with California Test 552.

Polyester concrete surfaces shall receive an abrasive sand finish. The sand shall be commercial quality blast sand conforming to the quality and dryness requirements for polyester concrete aggregate as specified in these special provisions. Ninety-five percent of the sand shall pass the 2.36-mm sieve, and 95 percent shall be retained on the 850- μ m sieve.

The sand finish shall be uniformly applied immediately after overlay strike-off and before gelling occurs to provide a minimum uniform coverage of 0.4 kilogram per square meter.

The finished surface of the polyester concrete overlays of the thicknesses listed in the Engineer's Estimate, shall be textured by grooving. Grooves shall be made parallel to the centerline of the traffic lane after the concrete has received the specified abrasive sand finish. Grooving shall be done in such a manner as to prevent the texture device from tearing the surface or causing the visible separation of coarse aggregate at the surface. Grooving of the polyester concrete surface shall conform to one of the following methods:

- A. Grooving operations shall conform to the requirements in Section 42-1, "Grooving," of the Standard Specifications.
- B. Grooves shall be made with spring steel tines. Spring steel tines of the final texturing device shall be rectangular in cross section, 2 mm to 4 mm wide, on 19 mm to 24 mm centers, and of sufficient length, thickness and resilience to form grooves approximately 5 mm deep in the fresh polyester concrete surface. Final texture shall be uniform in appearance and longitudinal grooves shall have a depth between 2 mm and 8 mm.

The surface texture of polyester concrete overlay surfaces shall be uniform and shall have a coefficient of friction of not less than 0.35 as measured by California Test 342. Portions of surfaces that do not meet the above provision shall be ground or grooved parallel to the centerline in conformance with the provisions of Section 42, "Groove and Grind Pavement," of the Standard Specifications until the above tolerance is met.

Traffic and equipment shall not be permitted on the overlay for a minimum of 4 hours following final finishing. Overlays shall be protected from moisture for a minimum of 4 hours after finishing.

The edges of the polyester concrete overlay shall be tapered when the overlay work is not completed within the allowable lane closure and the overlay is greater than 13 mm higher in elevation than the adjacent pavement. Edges that are transverse to the direction of traffic shall be tapered at a 1:20 (vertical:horizontal) slope, and edges that are longitudinal to the direction of traffic shall be tapered at a 1:4 (vertical:horizontal) slope. Tapers may remain and be overlaid with subsequent placement of polyester concrete overlay.

A tapered extension of asphalt concrete shall be constructed in conformance with "Asphalt Concrete" of these special provisions at the western edge of the polyester concrete overlay at the existing viaduct replacement structure adjacent to the westbound transition structure. The extension shall be tapered at a 1:30 (vertical:horizontal) slope.

MEASUREMENT AND PAYMENT

Furnishing polyester concrete overlays of the thicknesses listed in the Engineer's Estimate will be measured by the cubic meter. The volume to be paid for will be determined from calculations based on the quantity of resin binder used, the percent by weight of resin binder in the polyester concrete, and a unit weight of 2165 kg/m³. The Contractor shall furnish suitable measuring devices to assure correct proportioning of materials and accurate measurements for calculating payment quantities. The payment quantity shall be the calculated quantity of polyester concrete overlay used in the work, exclusive of material used in trial overlays and any wasted or unused material. When the plans show that unsound concrete patching material is polyester overlay, the payment quantity will include the patches.

Placing polyester concrete overlays of the thicknesses listed in the Engineer's Estimate will be measured by the square meter. The area to be paid for will be based on the dimensions shown on the plans.

The contract price paid per cubic meter for furnish polyester concrete overlays of the thicknesses listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing polyester concrete, including furnishing methacrylate resin prime coat and furnishing materials for trial overlays, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The contract price paid per square meter for placing polyester concrete overlays of the thicknesses listed in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the polyester concrete overlay (50mm), complete in place, including application of prime coat, constructing and disposing of trial overlays and base, grooving polyester concrete overlay surface, and furnishing and mixing color, but excluding airborne emissions monitoring work done by the certified industrial hygienist and notification of the public, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for furnishing and placing the asphalt concrete tapered extension at the existing viaduct replacement structure adjacent to the westbound transition structure shall be considered as included in the contract prices paid for the items of work involving polyester concrete overlay (19mm).

Full compensation for execution of the public safety plan, but excluding the airborne emissions monitoring work done by the certified industrial hygienist and notification of the public, shall be considered as included in the contract prices paid for the items of work involving polyester concrete overlays of the thicknesses listed in the Engineer's Estimate, and no additional compensation will be allowed therefor.

For polyester concrete overlays of the thicknesses listed in the Engineer's Estimate, airborne emissions monitoring with reporting done by the certified industrial hygienist and notification of the public will be paid for as extra work as provided in Section 4-1.03D, "Extra Work," of the Standard Specifications.

10-1.108 GAS PIPE

GENERAL

Summary

Existing gas line (U.S. Navy) is under the jurisdiction of the City and County of San Francisco (CCSF).

This work shall consist of furnishing and installing 50-mm and 100-mm gas pipe (U.S. Navy) complete with fittings, joinings, accessories and incidentals necessary to complete the work. in compliance with the requirement of Codes and Standards, and applicable provisions and requirement of the latest revisions of the U.S. Department of Transportation (DOT) Pipeline Safety Regulations CFR 49, Part 192, "Federal Minimum Safety Standards: Transportation of Natural and Other Gases by Pipeline," and conform with these special provisions.

CODES AND STANDARDS

All work performed and material installed or furnished shall conform to the applicable portions of the California Plumbing Code (CPC), the International Association of Plumbing and Mechanical Officials (IAPMO).

MATERIALS

Gas pipe and fittings shall be polyethylene natural gas pipe, Class 315, conforming to ASTM Designation: D 2513.

Pipe and fittings shall be extruded or molded from polyethylene resin which conforms to ASTM Designation: D 1248, Type II, Class B with antioxidants Category 5, Grade P23. Pipe shall be marked in accordance with ASTM Designation D2513. Fittings shall conform to ASTM Designation: D 3261.

INSTALLATION

Polyethylene natural gas pipe shall be installed in accordance with International Association of Plumbing and Mechanical Officials (IAPMO) Standard: IS12-2006. The depth shall be not be less than 1.1 meters.

Prior to backfilling of the polyethylene natural gas pipe, the Contractor shall furnish and install a continuous yellow warning tape, not less than 100 mm wide, with black lettering "CAUTION-BURRIED GAS LINE".

The warning tape shall be installed directly above the buried gas pipes at the depth of 150 mm to 300 mm below the finished grade.

The tracer wire shall be installed with buried pipes.

EXCAVATION, BACKFILL AND SAND BEDDING

Structure excavation and backfill, and sand bedding for the installation of the gas pipes shall conform to the provisions in Section 19.3, "Structure Excavation and Backfill," of these Standard Specifications.

MAINTAINING GAS SERVICES

The Contractor shall give the Engineer 48-hour advance notice prior to any interruption of the gas services. Any interruption to the gas services shall not exceed 8 hours. The City and County of San Francisco shall be given 48-hour notice in advance of any interruption to the system. The City and County of San Francisco can perform any necessary isolations, or in the case of poly-pipe, the Contractor shall clamp. The Contractor shall make all necessary connections to complete the work.

Testing

All piping shall be tested in the presence of the Engineer after assembly and prior to backfill, pipe wrapping, connecting fixtures, wrapping joints and covering the pipe. Systems shall show no loss in pressure or visible leaks. All piping shall be considered defective if it does not pass tests and inspections. The Contractor shall prepare and submit test and inspection reports.

The Contractor shall test gas supply system by air pressure testing to 345 kPa for a period of not less than 4 hours.

MEASUREMENT

The length of pipe to be paid for will be the slope length designated by the Engineer. No payment will be made for pipe placed in excess of the length designated.

PAYMENT

The contract price paid per meter for gas pipe of the size or sizes shown in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing the gas pipe, complete in place, including excavating for the pipe, and disposing of material resulting from the excavation, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for structure excavation, structure backfill, and shaped bedding, when gas pipe is installed by the open trench method, shall be considered as included in the contract price paid per meter for the the various sizes of gas pipe involved and no separate payment will be made therefor.

Full compensation for providing and installing the yellow (with black lettering) warning tape "CAUTION-BURIED GAS LINE" shall be considered as included in the contract paid for the various contract items of work and no additional compensation will be allowed therefor.

10-3.16 SUPERVISORY CONTROL AND DATA ACQUISITION REMOTE TERMINAL UNIT SYSTEM

GENERAL

The Contractor's attention is directed to "Order of Work" of these special provisions for the timely identification of the supplier of the remote terminal units and products to be used by the Contractor.

The State will arrange for the procurement and installation of a new Programmable Automation Controllers (PACs) and integrate into the existing SCADA system. The equipment will be installed on the Oakland Bay Bridge East Span. The communications protocol between field devices and the RTUs will be MODBUS. Communications between the RTUs and the SCADA Master Controller (HMI) shall be through the use of frequency shift key (FSK) modem.

The Contractor shall arrange for the procurement and installation of the SCADA remote terminal units (RTUs) with the Engineer prior to procurement and shall provide identical equipment to the San Francisco – Oakland Bay Bridge East Span Seismic Safety Project (Skyway Contract) to assure compatibility between the SCADA RTUs, the new Programmable Automation Controllers (PACs), and the existing SCADA Master PLC.

The Contractor shall arrange for the RTU supplier to generate complete wiring diagrams, based on shop drawings, of each RTU, showing all incoming cable and wire terminations to be terminated by the Contractors. The wire, cable and circuit numbers shall match and be coordinated with the RTU requirement plans (elementary and wiring diagrams), furnished for the SCADA RTU system. This information shall be available for the Engineer to review upon request prior to installing any of the RTUs.

SUBMITTALS

Each submittal package shall consist of six copies. Submittals shall be delivered to the Engineer at least 180 days prior to the start of the installation. The Engineer will be allowed 90 days for review of the submittals.

Submittals (For Review and Approval)

The following information shall be submitted to the Engineer:

- A. Master drawing index
- B. Front view elevation
- C. Floor plan
- D. Top view
- E. Block diagram
- F. Schematic diagram
- G. Nameplate schedule
- H. Component list
- I. Conduit entry and exit locations
- J. Assembly ratings including:
 - 1. Voltage
 - 2. Continuous current
- K. Cable terminal sizes

Key interlock schematic plans and sequence of operations shall be submitted to the Engineer:

Submittals (For Information)

When requested by the Engineer the following product information shall be submitted:

- A. Descriptive bulletins
- B. Product data sheets.

Submittals (For Final Acceptance)

The following information shall be submitted for record purposes prior to final payment:

- A. Final as-built plans and information for remote terminal units.
- B. Wiring diagrams
- C. Certified production test reports
- D. Installation information
- E. Seismic certification and equipment anchorage details.

Operation and Maintenance Manuals

Ten copies of the equipment operation and maintenance manuals shall be provided prior to shipment of the equipment. Operation and maintenance manuals shall include the following information:

- A. Instruction books or leaflets
- B. Recommended renewal parts list

PROGRAMMABLE CONTROLLER

Project Objectives

This specification describes the functional requirements, design features, hardware, software, system performance, services, and documentation required for a control in a scalable discrete or hybrid control system.

The control system shall perform as a minimum the following functions as defined in the specific sections of this document:

Control system must comply with the requirements for an Programmable Automation Control.

System must be open architecture with the control functions being modular and scalable

Optional redundancy for servers, controllers, networks, and I/O

High speed, deterministic, peer to peer communications between control systems

Ability to communicate with 3rd party devices and controllers with fieldbus connections

Integrated environment for all applications (discrete, process, motion, MMI) development, configuration, commissioning, monitoring, and maintaining with one database

Complete management system for all access levels to control application for necessary security requirements

Either integrated in the control system or through standards based connections (Ethernet, OPC), interface and share database with high level HMI/SCADA system with Historian, Trending, and additional functionality

Integrated Alarms and Events

Web connectivity for interface to control for monitoring and maintaining

Compliant with safety and environmental regulations

Programmable Automation Control Definition

The requirements for a Programmable Automation Control (PAC) are:

Multi-domain functionality, including logic, motion, and HMI for discrete and process control on a single platform

Will allow users & OEMs to deploy multiple control applications on a single platform

Common development platform for the design and integration of multi-domain automated systems

Other Definitions

PACSystems™: GE Fanuc's line of Programmable Automation Controllers. PACSystems takes PAC one step farther with a portable engine built on standards. This allows the same application to be run on multiple platforms.

Ethernet: A very high performance local area network standard providing the two lower levels of the ISO/OSI seven layer reference model, the physical layer and the data link layer.

TCP/IP: a protocol widely used across Ethernet networks for connecting computers and programmable controllers.

Web Browser: A client application that provides a user interface via the World Wide Web. Netscape and Microsoft Internet Explorer are two popular examples.

Communications Protocol: A formal set of conventions governing the control of Inputs and Outputs between the two communicating processes.

Network: An interconnected group of nodes, a series of devices, nodes or stations connected by communications channels.

CMX/RMX: Control Memory Xchange/Redundancy Memory Xchange – a new technology that communicates very large amounts of data at deterministic sub microsecond times.

Operating System: A program that controls the entire overall operation of the system hardware / software. PACSystems use standard operating systems to allow program portability and application flexibility.

Will facilitate open, modular control architectures that enable highly distributed automated factory environments

Employ de-facto standards for network interfaces, languages, etc., allowing data exchanges as part of networked multi-vendor systems

Manufacturer's Standards

The manufacturer shall have shown high commitment to product, manufacturing and design process quality. It shall have attained ISO9001 registration.

Design and Manufacture

The SCADA RTUs furnished by the Contractor, shall be part of the overall new San Francisco – Oakland Bay Bridge SCADA system, to be furnished and installed by multiple contractors. Therefore, to assure compatibility between SCADA components, the Contractor shall procure the RTUs from the same RTU supplier used in Contract 04-012024, Skyway. The new RTUs for the San Francisco – Oakland Bay Bridge shall be furnished with GE 90-30 PLCs. The RTU cabinets, including all internal subcomponents, shall, where applicable, be identical to the subcomponents furnished with the Skyway RTUs.

The SCADA RTU system shall be obtained from the following supplier:

VENDOR ADDRESS AND PHONE NUMBER
INKELIS ASSOCIATES 6722 CORTE SANTA MARIA PLEASANTON, CA 94566 TEL: 925-485-0794 FAX: 925-485-0794 CONTACT: KAREN INKELIS

The unit prices quoted by the supplier for the SCADA RTU system (including the Programmable Controller) are as follows:

Description	QTY	NTP 2011	NTP 2012	NTP 2013
COM-1W Terminal Cabinet	1	\$7,133	\$7,561	\$8,015
COM-2W Terminal Cabinet	1	\$7,133	\$7,561	\$8,015
COM-3W Terminal Cabinet	1	\$7,133	\$7,561	\$8,015
COM-1E Terminal Cabinet	1	\$7,133	\$7,561	\$8,015
COM-2E Terminal Cabinet	1	\$7,133	\$7,561	\$8,015
COM-3E Terminal Cabinet	1	\$7,133	\$7,561	\$8,015
TEL-1W Terminal Cabinet	1	\$6,562	\$6,956	\$7,373
TEL-2W Terminal Cabinet	1	\$6,562	\$6,956	\$7,373
TEL-3W Terminal Cabinet	1	\$6,562	\$6,956	\$7,373
TEL-1E Terminal Cabinet	1	\$6,562	\$6,956	\$7,373
TEL-2E Terminal Cabinet	1	\$6,562	\$6,956	\$7,373
TEL-3E Terminal Cabinet	1	\$6,562	\$6,956	\$7,373
RTU9E	1	\$63,500	\$67,310	\$71,349
RTU9W	1	\$63,500	\$67,310	\$71,349

The prices quoted are effective for each NTP (Notice to Proceed) yearly period from January 19 to January 18 of the following year. The FOB location is Everett, Washington. The above prices include freight and insurance, but do not include sales tax. All products are tested and ETL Labeled before shipment.

All of the components within the family of controller products shall be offered by a company who regularly manufactures and services this type of equipment.

The programmable controller and all of the corresponding components within the family of controller products shall be offered by a company who regularly manufactures and services this type of equipment.

All products shall be designed, manufactured, and tested in accordance with recognized UL and IEC mark industrial standards. The system shall be operational during and after testing. The standards requirements are as follows:

AGENCY APPROVALS OVERVIEW	Comments	
Quality Assurance in Design/ Development, Production, Installation & Servicing	ISO9001	Certification by Underwriters Laboratories and BSI Quality Assurance
Safety for Industrial Control Equipment	UL508	Certification by Underwriters Laboratories
	C-UL or CSA 22.2, 142-M1987	Certification by Underwriters Laboratories [C-UL] or Canadian Standards Association for selected modules
Safety for Hazardous Locations Class I, Div II, A, B, C, D	UL1604 with C-UL	Certification by Underwriters Laboratory for selected modules
	FM3611	Certification by Factory Mutual for selected modules
	CSA22.2, 213-M1987	Certification by Canadian Standards Association for selected modules
European EMC and Low Voltage Directives	CE Mark	Certification by Competent Body for EMC Directive for selected modules

STANDARDS OVERVIEW		Conditions
ENVIRONMENTAL		
Vibration	IEC68-2-6, JISC0911	IG @ 40-150 Hz, 0.012 in p-p @ 10-40Hz
Shock	IEC68-2-27, JISC0912	15G .11 ms
Operating Temperature		0°C to 60°C:[inlet] 0°C to 55°C:[ambient]
Storage Temperature		-40°C to +85°C
Humidity		5% to 95%, non-condensing
Enclosure Protection	IEC529	Steel cabinet per IP54: protection from dust & splashing water
EMC EMISSIONS		
Radiated Conducted	CISPR11, EN55011 FCC	Class A [applies to CE Marked modules] part 15, subpart J, Class A
EMC IMMUNITY [applies to CE Market modules]		
Electrostatic Discharge	IEC 1000-4-2	8 kVAir, 4 kV Contact
RF Susceptibility	IEC 1000-4-3	10 V _{rms} /m80Mhz to 1000Mhz, 80% AM
Fast Transient Burst	IEC 1000-4-4	2 kV:power supplies,1KV:I/O,communications
Surge Withstand	ANSI/IEEE C37.90a IEC255-4	Ring Wave, 2.5 kV: Power supplies, I/O [12,240V] Ring Wave, Class II: Power supplies, I/O[12,240V]
Conducted RF	IEC 1000-4-6	10 V _{rms} , 150khz to 80 Mhz, 80%AM: communication modules with cables>30 m
ISOLATION		
Dielectric Withstand	UL508, UL840, IEC664	1.5 kV for modules rated from 51 V to 250 V
POWER SUPPLY		
Input Dips, Variations	IEC 1000-4-11	During Operation: Dips to 30% and 100%, Variation for AC ±10%, Variation for DC ±20%

The manufacturer shall have a fully operational quality assurance and quality control program in place and shall comply with ISO9001 standards for "Quality Systems- Model for Quality Assurance in Design/Development, Production, Installation, and Servicing."

Complete documentation describing installation, operation, programming and simple field maintenance shall be available in paper format and on CD-ROM.

Support

The manufacturer or its authorized representative shall provide complete technical support for all of the products. This shall include headquarters or local training, regional application centers, and local or headquarters technical assistance. A toll-free (800) number hot-line shall be available for emergency support.

Product shall have a warranty period of at least 1 year from the date of purchase. The contractor shall maintain the warranties of the product to the completion of the project.

Hardware

The system shall consist of rugged components designed specifically for industrial environments. A complete system shall consist of one or more racks containing I/O modules, interconnected by signal cables.

Packaging

All components shall be housed in structurally secure enclosures.

The controller CPU shall be modular. The modular type shall be fully enclosed within a durable plastic shroud. When mounted on the system base, the modular CPU shall not occupy more than one available slot.

The I/O system shall be modular. Each module shall be fully enclosed within a durable plastic shroud. When mounted on the system base, each I/O module shall not occupy more than one available slot.

There shall be at least two sizes of I/O bases available. One shall hold up to 10 I/O modules and the other shall hold up to 5 I/O modules.

I/O modules shall be retained in their slot by a hinge on the upper rear edge and snap on the lower rear edge of the baseplate. Removing the module shall require no tools.

I/O modules shall be installed in any available slot in the CPU or expansion baseplates, and shall require no tools for insertion and extraction.

I/O modules shall connect electrically to the baseplate via a pin and socket connector.

I/O modules shall be fully enclosed in a plastic covering protecting the electronic circuitry from exposure.

Durability

All components within the controller family shall be manufactured with a high degree of durability.

All switches and other operator-controlled devices shall be of the size and durability for the intended use as is normally offered for industrial applications.

All signal cables furnished by the manufacturer shall be constructed so as to withstand, without damage, all normal use and handling.

Parts Interchange

In order to minimize spare parts stocking requirements, the controller family shall have a high degree of interchange capability. The power supply, and the battery, and should all operate equally well regardless of the CPU being used.

The system shall incorporate a modular design using plug-in assemblies with pin and socket connectors.

Wherever possible, all assemblies and sub-assemblies performing similar functions shall be interchangeable.

The system design shall accommodate the replacement of assemblies without having to disconnect field wiring. Wherever possible, removable connectors shall be used to connect field wiring to the individual circuit board assemblies.

All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings each of which indicates the manufacturer's catalog number, product manufacturing date code, UL and CSA certifications.

Environmental Conditions

All components of the controller system, except CRT terminals and programming workstations, shall meet the following environmental specifications:

Storage Conditions: Temperature from -40°C to 85°C.

Operating Conditions: Temperature from 0°C to 60°C.

Humidity: From 5 percent to 95 percent relative humidity, non-condensing.

Power Supply Module

The power supply shall be a wide range supply operating from a voltage source in the range 120 V(ac) to 264 V(ac) and from 90 V(dc) to 125 V(dc), providing 30 watts of power. Available power shall be 30 watts at a +5 V(dc) output, 15 watts at a 24 V(dc) relay power output, and 20 watts at an isolated 24 V(dc) output.

Specifications

The power supply shall contain an isolated, internal 24 V(dc) power source for I/O modules requiring 24 V(dc) power. The power supply shall contain a built-in serial communication port which can be used to:

- A. Connect the programmer for PC compatible programming software.
- B. Connect to one of the wide variety of third-party operator interfaces utilizing an open architecture software protocol.

This serial port shall provide RS-422 signals with RS-485 compatibility. The characteristics of this port shall be software configurable and shall be modem compatible.

The power supply shall contain dual battery connectors in a battery compartment such that a battery may be installed to protect programming CMOS RAM memory. Dual connectors are required to provide bumpless battery power transfer.

The backup battery for RAM memory shall be a Lithium, long-life battery with a typical life of 6 months under load, and 8 to 10 years under no load. This battery shall be replaceable while power is applied to the PLC.

The power supply shall be modular in design, separate from the CPU and baseplate for easy replacement in the unlikely event of failure.

The power supply shall be universal in design, compatible with main CPU racks, as well as with expansion racks.

There shall also be a super capacitor that provides a minimum of 1 hour battery less backup power for CPU RAM memory.

Central Processing Unit (CPU)

The CPU shall be a modular CPU with up to 5 different configurations. The CPU shall possess the capability to solve application logic, store the application program, store numerical values related to the application processes and logic, and interface to the I/O systems. The CPU shall need no additional modules to provide at least the following advanced programming features: PID, Modulo, Math, Double Precision math, Logical functions, Subroutines, Data Array Move and Indirect Addressing.

Modular CPU

The modular type CPU shall contain: A microprocessor operating at speeds no less than 300 MHz as the main processing element, memory mounted on the board. A minimum of 10 Megabytes of memory shall be on board for user configurable application, data storage and documentation storage.

The modular type CPU shall contain a real-time calendar and clock that can be accessed by the user program. This Time of Day clock and calendar shall be battery-backed and maintain seven time functions: Year (2 digits minimum), Month, Day of Month, Hour, Minute, Second, and Day of week.

The modular CPU shall execute Boolean functions at a rate of 0.3 microseconds per instruction or lower.

The modular CPU shall be capable of controlling up to 79 I/O slots.

The modular CPU shall be able to provide special functions such as High Speed Counter function, Axis Positioning function, and Local Area Networking function.

The CPU shall be able to provide 2 serial ports, 19 pin RS232 and 15 pin RS485 for communications.

The modular CPU shall contain a battery slot to support backup power for the SRAM

A RUN ENABLED/RUN DISABLED/STOP switch shall be on the CPU behind a door for security.

LEDs on the CPU shall indicate the following:

- CPU OK
- RUN mode
- Outputs Enabled
- I/O Force
- Battery condition
- System faults
- Comm 1 activity
- Comm 2 activity

Visual Diagnostics

Status of low or dead battery shall be indicated by a red Battery LED on the power supply module.

The diagnostic status of the fuses, for those discrete I/O modules containing fuses, shall be indicated by a red LED mounted on the top of the module. The red LED shall illuminate when a blown fuse condition is present.

Alarm Processor

The modular CPU's shall contain an alarm processor that has special PAC feature designed to receive and process faults. The diagnostics shall provide information on the configuration and CPU, memory, communications and I/O status.

The alarm processor function shall log I/O and system faults in two fault tables that shall be accessible for display on the PC compatible programming software screen or uploaded to a host computer or other coprocessor.

The alarm processor shall maintain the states of up to 128 discrete system diagnostic bits to be read by a host or incorporated as contacts into the ladder program for customized diagnostic routines.

Each fault table shall have a total capacity of 32 faults. The last 16 entries shall maintain the latest 16 faults. The first 16 shall be kept unchanged.

Faults may be cleared by the user by way of a programmer. Provision shall be made by way of passwords to protect these faults from unauthorized clearing.

Alarm Features

The alarm processor shall report three types of fault action; fatal, diagnostic, or informational, and the CPU shall respond as follows:

Fault Action	Fatal	Diagnostic	Informative
CPU Enters STOP Mode	YES	NO	NO
Set Diagnostic Bit	YES	YES	NO
Logged In Fault Table	YES	YES	YES

When an I/O fault occurs, the alarm processor shall report the rack and slot location of the fault, the condition, the address and the circuit number if appropriate.

The modular CPU alarm processor function shall have the capability to time-stamp system faults for future references.

PLC Memory Protection

The PLC shall have 4 levels of security or password privilege levels to prevent unauthorized changes to the contents of the PAC. These built-in privilege levels shall be set in the programming software or with the Hand-Held Programmer and shall impose the following constraints:

Level	Constraint
1.	Read PLC data only (except passwords)
2.	Write to any data memory
3.	#2 and write to all configuration or logic in STOP mode
4.	#3 and write to logic in STOP or RUN mode (on-line change) and password level access.

There shall be one password, one to four ASCII characters in length, for each privilege level in the PAC, and the same password can be used for more than one level.

Any attempts to access or modify information in the PAC without the proper password privilege level shall be denied.

Subroutine Password

The PAC shall have a software OEM key that allows users to control access to each subroutine in the relay ladder program.

OEM Program Protection

The PAC shall have a software OEM key that allows users to protect the resident program from unauthorized reads and writes.

CPU Memory

The PAC shall supply a modular design CPU that contains at least the following:

- A. 10 Megbytes for application programming
- B. Configurable up to 5 Meg 16-bit registers for register and data usage
- C. Up to 32 K control relays internal battery backed
- D. Up to 32 K bits for discrete inputs
- E. Up to 32 K bits for discrete outputs
- F. Configurable up to 32 K 16-bit registers for analog inputs
- G. Configurable up to 32 K 16-bit registers for analog outputs

All application memory shall be available to the user program. Executive level operations performed by the CPU shall not consume application memory.

Memory Storage

The register values and the application program shall be stored in battery backed, CMOS static RAM memory. The application program and system configuration shall also be stored in FLASH memory.

There shall be a long-life Lithium battery used to maintain the contents of the CMOS RAM memory in the CPU.

There shall be an easily accessible battery compartment in the power supply with dual battery connectors. The battery shall be replaceable with power applied to the PAC and without removing the CPU.

An LED shall provide visual indication of the battery condition. Additionally, a low battery condition shall be alarmed with a system diagnostic bit.

The modular CPU shall allow the resident user program to be maintained in the CPU without power applied. Two levels of maintainability shall be provided, short duration and long duration.

For short duration, the program shall be maintained by a hi-capacity capacitor for a period of no less than 1 hour. This allows adequate time for replacing the battery in the power supply module, should the external supply to the CPU be interrupted.

For long duration, the CPU module shall maintain its contents by using the battery. This allows the CPU module to be shipped via surface mail where power supply to the module is not available. This method may be achieved by providing internally mounted battery. If the CPU module does not have an internal battery then an external battery board may be used.

The CPU shall calculate the application program checksum at the end of every sweep. A complete checksum calculation for a program may take several sweeps. A fixed number of program memory checksum shall be calculated each sweep. This number is configurable by the user. If the calculated checksum does not equal the reference checksum, a fault shall be recorded, and the CPU mode will change to STOP.

Programming Devices

A software programming package, for development of application programs, shall be furnished. The software programming package shall be capable of running on a PC compatible laptop or desktop computer.

On-line and off-line, CPU and I/O configuration and application program development shall be achieved with a PC compatible computer and programming and documentation software.

The PC compatible computer shall be connectable to the PAC via a built-in serial communication port on the power supply or serial ports on the CPU. In addition to the serial communications, the PC compatible computer shall be connectable to the PAC via Ethernet TCP/IP supporting the SRTP application protocol. A separate module providing Ethernet communications through 10baseT connection shall plug into any system.

The programming devices shall have access to the application program, the CPU and I/O system configurations, all registers, CPU and I/O status, system diagnostic relays, and I/O over-ride capabilities.

Operator Interface

The programming port and its protocol shall be open in architecture. The protocols of this communication port shall be published such that a user may develop their own operator interface device, software or hardware, to access Register, I/O status, I/O override and system diagnostic memory data.

Through an open nature of this communications protocol, a wide variety of operator interface shall be made available. These may be manufacturer's own brand or they may be manufactured by 3rd party vendors.

Programming Language

The CPU shall be capable of solving an application program whose source format shall be relay ladder diagram. The language shall support relay, timers and counters, arithmetic, relational, bit operation, data move, conversion, and control functions.

The CPU shall be capable of solving an application program whose main program format is in Sequential Function Chart (SFC) with underlying code in relay ladder diagram.

Relay Functions

Relay ladder operations shall consist of the following contacts and coils:

- A. Normally Open Contact
- B. Normally Closed Contact
- C. Coil
- D. Negated Coil
- E. Retentive Coil
- F. Negated Retentive Coil
- G. Positive Transition Coil
- H. Negative Transition Coil
- I. Set Coil (Latch)
- J. Reset Coil (Unlatch)
- K. Retentive Set Coil
- L. Retentive Reset Coil

Positive transition coils and negative transition coils shall function as leading and trailing edge one-shot coils respectively.

Contacts may be referenced any number of times within the application program.

A single rung may contain more than one coil.

There shall be a service that allows user programs to be checked for multiple coil use. This flag may be set to:

- A. Disallow more than one coil in a single rung
- B. Allow multiple coil use but generate warning messages
- C. Allow multiple coil use without warnings

Timers And Counters

Timer and counter operations shall consist of the following functions:

- A. Retentive On-Delay Timer (ONDTR)
- B. Simple Off-Delay Timer (OFDT)
- C. Simple On-Delay Timer (TMR)
- D. Up Counter (UPCTR)
- E. Down Counter (DNCTR)

The retentive on-delay timer shall behave as a stop-watch that increments time when enabled and holds the current timed value until receiving power flow to the reset input.

The simple on-delay timer shall increment while it receives power flow and reset to zero when power flow stops.

The simple off-delay timer shall increment while it power flow stops and reset to zero when power flow is present.

There shall be at least 10,666 programmed timers and counters available for use in application programs.

Each timer or counter requires the use of three 16-bit registers within %R memory for storage of the preset, the current value and a control word. These three registers shall be accessible to the user via a register reference.

The timers and counters shall not require an output reference, the output of a timer or counter can be used to energize a coil, or enable another function, such as a math function, or another timer or counter.

The time/count limit shall be either a programmed constant or shall be programmable via a register reference value.

The time shall be counted in tenths of seconds or hundredths of seconds, and the range for the timers and counters is 0 to 32,767 time units.

Arithmetic

The arithmetic operations shall support two data types, Signed Integer (INT), and Double Precision Integer (DINT). On the modular CPU, the Floating Point data type shall also be supported via floating point emulation. Arithmetic functions shall consist of the following types:

- A. Addition
- B. Subtraction
- C. Multiplication
- D. Division (quotient)
- E. Modulo (remainder)
- F. Square Root

Signed Integers (INT) data shall be stored in 16 contiguous bits of memory, in 2's complement notation. The range for Signed Integer Data shall be -32,768 to +32,767.

Double Precision Integer (DINT) data shall be stored in 32 contiguous bits of memory, double precision data is always signed.

The arithmetic function blocks shall consist of 3 inputs and 2 outputs. The enable input shall begin the execution. When the function is enabled, the two data inputs are operated upon and the result is output. There shall also be an OK output that is always true when the function is enabled, unless an overflow or other error exists.

All of the Arithmetic functions shall be such that they can be cascaded together in a single rung.

Relational Functions

Relation Functions which are used to compare two numbers, shall operate on Signed Integer and Double Precision Integer data types, and shall consist of the following types:

- A. Equal To Not Equal To
- B. Greater Than Greater Than or Equal to
- C. Less Than Less Than or Equal to

Bit Operation Functions

Bit Operation Functions shall perform comparison and movement operations on word data that is specified as a continuous string of data in 16-bit increments, with the first bit of the first word being the least significant bit, and the last bit of the last word being the most significant bit.

Bit Operation Functions that are used to perform Boolean operations on corresponding bits of two bit strings of the same length shall consist of the following types:

- A. Logical AND
- B. Logical OR
- C. Logical Exclusive OR

Bit Operation Functions used to create an output string that is a copy of an input bit string, but with its bits inverted, shifted, or rotated shall consist of the following types:

- A. Logical Invert (NOT)
- B. Shift Left
- C. Shift Right
- D. Rotate Left
- E. Rotate Right

The shift functions shall allow for the user to specify the number of places that the array is to be shifted as an input, and provide the state of the last bit shifted out, and a copy of the shift register as outputs.

Data Move Functions

Basic data movement capabilities shall be provided by the following list of functions:

- A. Move
- B. Block Move
- C. Block Clear
- D. Shift Register
- E. Bit Sequencer
- F. Range
- G. Communications Request

The movement of data (16 bit integer or word), as individual bits, from one location to another shall be accomplished by the Move function. The user shall be able to specify the length of the move.

The Block Move function shall provide the functionality to move a block of 7 constants (integer or word) to a specified location.

The ability to fill a specified block of data (word) with zeros shall be accomplished by the Block Clear function. The user shall be able to specify the length of the block.

The Shift Register function shall provide the functionality to shift one or more data words from a reference location into a specified memory location. All of the data within the Shift Register shall be accessible throughout the program from logic addressed memory.

A method of shifting a bit sequence through an array of bits shall be provided by a Bit Sequencer function. The function shall provide the ability to reset the sequence, change the direction of the bit pattern, or access the step location within the array.

A method of checking for a value to be contained within a group of values shall be provided in a Range function.

Provisions to initiate communications with a specialized communication module shall be made through the use of a Communication Request function. This function shall allow the PAC to behave as a master on a serial communication link, thus providing the ability to communicate master/slave or peer to peer with any controller or computer using the same serial communication protocol.

Table

Table operations shall consist of moving data into or out of tables and searching for data of values equal to, not equal to, greater than, greater than or equal to, less than and less than or equal to a specified value as listed below:

- A. Array moves
- B. Search Equal
- C. Search Not Equal
- D. Search Greater Than
- E. Search Greater Than or Equal to
- F. Search Less Than
- G. Search Less Than or Equal to

The array move feature shall be capable of implementing indirect addressing applications.

Conversion Functions

Two conversion functions shall be provided to convert a data item from a 4 digit Binary Coded Decimal (BCD-4) data type to a 16 bit signed integer and vice versa.

Control Functions

Control functions shall be provided to limit program execution, alter the way the CPU executes the application program, or provide special PAC services. The following Control Functions shall be provided:

- A. CALL
- B. Immediate I/O update (DO I/O)
- C. Comment rung (COMMNT)
- D. Master Control Relay (MCR, END MCR)
- E. Jump to a label (JUMP, LABEL)
- F. Special Service Requests (SVCREQ)

An immediate I/O update function shall be provided for the update of all or a portion of the inputs or outputs for one scan while the program is running, or to update I/O during the program in addition to the normal I/O scan.

Additionally, the function shall provide a mean to read inputs into memory auxiliary to the true input table, and execute outputs from discrete memory alternate to the true output table.

A comment rung function shall be provided to enter a rung explanation in the program. The rung explanation shall have the capacity to hold 2048 characters of text. The memory required for the comment shall be independent of the program storage memory. The comment shall have the ability to be edited via the PC compatible programming software.

A master control relay function shall allow all rungs between the MCR and its subsequent END MCR function to be executed without power flow.

A method for structuring the ladder program shall be provided with the use of a JUMP Function. This will cause the program execution to jump to a specified location in the logic targeted by the location of the LABEL function.

Seven different special PAC service requests shall be accessible by the programmer by utilizing one of the Service Request Functions listed below:

- A. Change/Read Checksum Task State and
- B. Logical Number of Words to Checksum
- C. Change/Read Time of Day Clock
- D. Shut Down the PLC
- E. Clear Fault Tables
- F. Read Last Fault Table Entry
- G. Read Elapsed time Clock
- H. Read I/O Override Status

The Data written by these service request functions shall be in BCD or Packed ASCII format, and written into user definable register locations.

PID Function

A single PID function block instruction must be provided by the CPU without any additional module. Two versions of this closed loop control algorithm (Proportional/Integral/Derivative) shall be available:

- A. The standard ISA PID algorithm, which applies the proportional gain to each of the proportional, derivative, and integral terms; and
- B. The independent algorithm that applies the proportional gain only to the proportional gain term.

Subroutine Function

A single function block must be available to allow repetitive call of a function. A password to protect the integrity of the subroutine must also be available.

A Subroutine may be called from within another subroutine. The nesting must be at least 8 deep.

A Periodic Subroutine shall be available that is executed once a programmable interval. The interval shall be between 1 and 10 milliseconds. The accuracy of the subroutine execution shall be 50 nanoseconds. Discrete I/O shall be available to update during the execution of the subroutine.

Discrete I/O

Interface between the PAC and user supplied input and output field devices shall be provided by rack type I/O modules.

Configuration

There shall be an expandable system.

An expandable I/O system shall be supported by a single slot modular CPU, and shall accommodate up to 8 total racks or 79 I/O slots up to a total distance of 50 feet with the standard expansion racks and 700 feet with the remote expansion racks.

Serial expansion I/O racks shall be connected to the CPU rack via a high speed serial interface cable. The receiver shall be contained within the expansion baseplates eliminating the requirement for additional communication modules.

Ethernet expansion racks shall be connected via a 10/100Mbs Ethernet, EIA-568 connection. The Ethernet network interface unit shall reside in the rack using the same I/O that is compatible with the controller. The Ethernet network interface unit shall support the following:

- A. Built-in switch to allow daisy chain connection to the next Ethernet network interface unit.
- B. Support redundant controllers with automatic switch over.
- C. Ethernet network interface unit shall support up to 79 I/O modules per drop with local expansion.

I/O Addressing

I/O reference addressing for each I/O module shall be assigned through the use of the PC compatible configuration and programming software or the hand held programmer. There shall be no jumpers or DIP switch settings required to address modules.

The circuit status of each I/O point on a module shall be indicated by a green LED mounted at the top of the module. These LED's must be visible through a clear plastic lens. Each LED shall illuminate a letter and number which corresponds to the energized I/O circuit.

Addressing of all references including I/O must be represented as a Decimal Based number.

Construction

Terminal blocks shall be easily removable, and common to all discrete and analog I/O to allow for convenient pre-wiring of field devices.

Each I/O module shall contain a hinged, clear plastic, terminal block cover (door) with a removable label.

The inside of the label shall have the module description, catalog number, and circuit wiring diagram for that module type, and the outside of the label shall have a user legend space to record circuit identification information.

The label shall have color coding for quick identification of the module as high voltage (red), low voltage (blue), or signal level (gray) type.

Electrical Specifications

I/O modules shall be designed for 1500-volt isolation between the field wiring and the system backplane.

Input Specifications

The 120 Volt AC input module shall accommodate an input voltage range from 0 to 132 volts.

The 240 Volt AC input module shall accommodate an input voltage range from 0 to 264 volts.

The 24 Volt DC positive and negative logic input modules shall accommodate an input voltage range from 0 to +30 volts DC.

The 125 Volt DC input module shall accommodate an input voltage range from 0 to 150 volts.

Availability Of Input Modules

As a minimum, the following discrete input modules shall be available:

Description	Points/Module
Input Simulator	8, 16
120 V(ac) Isolated Input	8
240 V(ac) Isolated Input	8
120 V(ac) Input	16
24 V(ac)/V(dc) Negative Logic Input	16
24 V(dc), Positive/Negative Logic Input	8,16,32
24 V(dc) Positive/Negative Logic Input, (1ms response)	16
125 V(dc) Positive/Negative Logic Input	8
5/12 V(dc) Positive/Negative Logic Input (TTL)	32

Output Specifications

Discrete AC output modules shall have separate and independent commons allowing each group to be used on different phases of AC supply.

Each discrete AC output shall be provided with an RC snubber to protect against transient electrical noise on the power line.

Discrete AC outputs shall be suitable for controlling a wide range of inductive and incandescent loads by providing a high degree of inrush current (10x the rated current).

Discrete DC output modules shall be available with positive and negative logic characteristics in compliance with the IEC industry standard.

Discrete DC output modules shall be provided with at least eight output points in a group with a common power input terminal per group.

Discrete DC output modules shall be compatible with a wide range of user-supplied load devices, such as: motor starters, solenoids, and indicators.

A 2 Amp relay output module shall be capable of supplying 2 Amps resistive maximum load per output and 4 Amps resistive maximum load per group of 4 outputs.

A 4 Amp relay output module shall have 8 isolated outputs per module and shall be capable of supplying 4 amps resistive maximum load per output and 32 amps resistive maximum load per module.

Availability Of Output Modules

As a minimum, the following discrete output modules shall be available:

Description	Points/Module	# Fuses/ Rating	Module
120 V(ac), 0.5A (2 groups)	12,16	3A	2
120/240 V(ac), 1A (2 groups)	8	3A	2
120/240 V(ac) Isolated, 2A	5	3A	5
12/24 V(dc) Positive Logic, 2A	8	5A	2
12/24 V(dc) Positive Logic, 0.5A	8,16,32	N/A	0
12/24 V(dc) Negative Logic, 2A	8	5A	2
12/24 V(dc) Negative Logic, 0.5A	8,16	N/A	0
125 V(dc) Positive/Negative Logic, 1A	6	N/A	0
5/12/24 V(dc) Negative Logic, 0.5A	32	N/A	0
Relay, Normally Open, 2A (4 groups)	6	N/A	0
Relay, Normally Open, 4A Isolated	8	N/A	0
Relay, Isolated, 4 Normally Closed,	8	N/A	0
4 Normally Open (Form B & C) 8A			

Availability Of Mixed I/O Modules

As a minimum, the following discrete output modules shall be available:

Description	Points/Module
24 V(dc) Input, Relay Output	8 in, 8 out
120 V(ac) Input, Relay Output	8 in, 8 out

Analog I/O

For the conversion of analog to digital and digital to analog conversion required by an application, the following shall be available:

Analog Voltage Input

The analog voltage input module shall be capable of converting 4 or 16 channels of inputs in the range of -10 to +10 volts.

Resolution of the converted analog voltage input signal shall be 12 bits binary or 1 part in 4096.

All of the channels of converted analog voltage input signals shall be updated each scan into a dedicated area of data registers in a 16-bit 2's complement format.

The conversion speed for all of the analog voltage input channels shall be no less than 2 milliseconds and no greater than 13 milliseconds..

The analog voltage input module shall be configurable for a 4 to 20 mA analog current input via an external resistor.

Analog Current Input

The analog current input module shall be capable of converting 4 or 16 channels of inputs in the range from 4 to 20 mA or 0 to 20 mA.

Resolution of the converted analog current input signal shall be 12 bits binary or 1 part in 4096.

All of the channels of converted analog current put signals shall be updated each scan into a dedicated area of data registers in a 16-bit 2's complement format.

The conversion speed for all analog current input channels shall be a minimum of 2 ms and no greater the 13 ms.

Analog Voltage Output

The analog voltage output module shall be capable of converting 2 or 8 channels of digital data to analog outputs in the range from -10 V to +10 V.

Resolution of the converted output signal shall be 13 bits or 16 bits.

All channels of analog output data shall be updated each scan from a dedicated area of data registers in a 16-bit 2's complement format.

The analog voltage outputs shall be configurable to default to 0 volts or hold-last-state in the event of a CPU failure.

Analog Current Output

The analog current output module shall be capable of converting 2 or 8 channels of digital data to analog outputs in the range from 0 mA to 20 mA or from 4 mA to 20 mA.

Resolution of the converted output signal shall be 12 bits or 16 bits.

All channels of analog output data shall be updated each scan from a dedicated area of data registers in a 16-bit 2's complement format.

The analog current outputs shall be configurable to default to 0 mA, 4 mA or hold-last-state in the event of a CPU failure.

Analog Combination

The analog combo module shall be capable of converting 4 channels of analog inputs to digital data and 2 channels of digital data to analog outputs.

All channels are configurable for 0 mA to 20 mA, 4 mA to 20 mA, 0 V to +10 V, and -10 V to +10 V. Resolution of the converted input signals shall be 12 bits and output signals shall be 16 bits.

All channels of analog data shall be updated each scan from a dedicated area of data registers in a 16-bit 2's complement format.

The analog outputs shall be configurable to default to 0 percent of scale or hold-last-state in the event of a CPU failure.

Module Availability

As a minimum, the following analog modules shall be available:

Description	Channels/Module
Current Analog Input	4, 16
Voltage Analog Input	4, 16
Current Analog Output	2, 8
Voltage Analog Output	2, 8
Combo Analog Inputs/Outputs	4/2

Temperature Control Module

A specialized temperature control module shall be available to accommodate applications where precise temperature control is needed.

The temperature control module shall support auto-tuning, closed looped PID control, and open looped manual control.

The temperature control module shall provide eight thermocouple inputs, 1 RTD input, and 8 PID-controlled output channels for controlling heaters.

Motion Control

Specialized analog and digital motion control modules shall be available to perform 1 or 2 axes of closed or open loop servo control. These modules shall support encoder feedback with analog output for velocity command.

The positioning mode shall support linear and S curve acceleration and deceleration.

The modules shall provide user-defined control inputs and outputs for application such as torque follower and flying cut-off applications.

The modules must have user defined inputs and outputs, an English-language programming software, and automatic data transfer of data between PLC and axis positioning module with no user programming.

The positioning mode shall have a powerful instruction set, that includes absolute or incremental move, wait to move, dwell, conditional jump and subroutine functions.

The modules shall provide non-volatile program storage without the use of battery or super capacitor.

The follower mode shall provide either parallel or cascade operation from a single master.

The follower mode shall provide a selectable master source of encoder, analog, or internal time base.

The single axis module shall have a position loop update time of not more than 1 msec. The dual axis module shall have a position loop update time of not more than 2 ms per axis.

High Speed Counter

A specialized high speed counter option module shall be available to accommodate applications where pulse input rates exceed the input capability of the PAC .

The high speed counter module shall provide direct processing of rapid pulse signals up to 80 kHz in frequency.

The high speed counter module shall be configurable as four independent counters counting either up or down, two independent bi-directional counters, or one counter that can calculate the difference between two changing count values.

Speciality I/O And Communications

Based on open architecture specifications of the vendor and explicit permission of the vendor, specialty module shall be available such as PID, Co-processor, stepper, etc.

Complete documentation, kits for building modules, and engineering resource shall be available for the 3rd party based on the type of development.

Peer/Peer Communications

A specialized option module shall be available that will allow the PAC to communicate on a token passing peer-to-peer, noise immune network providing high-speed transfer of control data.

The specialized communication module shall be configurable to broadcast data to and receive data from up to 31 other devices on a network automatically and repeatedly from a shared and dedicated database in RAM memory.

The communication medium for this specialized network shall be a high energy and noise immune single shielded twisted pair cable transmitting data at an adjustable rate of up to 153.6 k baud. The distance of the communication shall be up to 2286 m at a lower baud rate.

Master/Slave Communications

There shall be modules (such as a Modbus RTU protocol module as specified elsewhere in these special provisions) that allows the PAC to act as a master in a communication scheme that allows the PAC to interrogate other PACs and devices for data.

PAC and CNC I/O Interface

The I/O interface shall provide an interface between the PAC and a CNC, allowing a CNC to control 64 I/O points on the PAC.

Client/Server Interface

There shall be a module that provides CLIENT/SERVER with PEER to PEER communications over Ethernet TCP/IP. The modular CPU system and special module shall support up to 16 simultaneous connections.

FSK MODEM

The format of the FSK modem shall be standard RS232C with four-wire operation for long range up to 12.2 km. Mode of operation will be point-to-point or multi-drop. Data transmission speed shall be up to 9600 baud. Modulation shall be frequency shift key (FSK); carrier signal transformer and capacitively isolated. Interface shall be DTE/DCE jumper selectable; Female DB25 connector for RS232C; two position pluggable terminal block for carrier; 2.5 mm x 5.5 mm barrel jack (center positive) for 24 V(dc). A wall mounted power supply shall be provided for 120 V(ac) input and 21 V(dc) – 28 V(dc) output. The FSK modem shall be designed for a temperature range from 0°C to 60°C and humidity from 0 to 95 percent, non condensing. Enclosure shall be 16-gauge steel with mounting flanges.

MODBUS RTU MASTER MODULES

The RTU Master Modules shall support the Modbus protocol and shall be compatible with the CPU. The RTU Master Modules shall provides four independent, isolated serial ports. Up to six RTU Master Modules can be located in the main PAC backplane.

Each port can be configured for MODBUS Master, MODBUS Slave, or Serial I/O protocol. MODBUS Master mode exchanges with up to 64 individual slaves are set up during module configuration, and easily controlled from the application program with no special messaging required. The RTU Master Modules shall automatically supplies the MODBUS message structure including device address, function code, and error check information, based on the configuration of the exchange. Broadcast messaging is not supported.

MODBUS Slave mode exchanges can be set up for automatic mapping to CPU memory, so that no application programming is necessary for a port used as a MODBUS Slave.

The RTU Master Module shall included:

- Port-to-port isolation and port-to-backplane isolation.
- RS-232, RS-485/422 communication, software-selected
- Hardware handshake: RTS/CTS (for RS-232 only)
- Selectable Baud Rates: 1200, 2400, 4800, 9600, 19.2K, 38.4K, 57.6K, 115.2K
- Module fault status reporting (Watchdog, Ram Fail, Flash Fail)
- Module identity and status reporting, including LED status indicators
- Hot insertion/extraction
- Meets CE, UL/CUL 508 and 1604, and ATEX requirements
- Flash memory for future upgrades and protocol additions
- Function codes: 01, 02, 03, 04, 05, 06, 07, 08, 15, 16, 17, 20, and 23.

INSTALLATION REQUIREMENTS

Two Remote Terminal Units (RTUs) shall be installed by the Contractor. The RTU's are to be installed and wired as shown on the plans.

The Contractor shall be responsible for making a complete, operational loop check of each circuit installed by the Contractor and connected to the input and output terminals of the RTU. Loop checks shall be performed by simulating a contact closure as necessary to prove the operation of each circuit. The complete functional check including the SCADA existing Master PLC and workstations shall be performed under different contracts.

VENDOR REQUIREMENTS

Development Life Cycle

The vendor must have an established documented development procedure. This procedure must track customer requirements, development risk, and corrective action. The procedure must include a product validation cycle.

The vendor must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software. The presence of a formal quality assurance department shall be required.

The vendor must also demonstrate that it's source code for the product is regularly archived with suitable backup.

The vendor must follow a documented configuration management system.

Product Life Cycle

The vendor must have an established product life cycle policy. Documentation of the product life cycle shall be available.

Manufacturer Qualifications

The manufacturer shall have shown a high commitment to product, manufacturing and design process quality. The manufacture shall be ISO 9000 registered.

The manufacture shall have fully operational quality assurance and quality control programs in place. Complete documentation describing the quality assurance and quality plan shall be available.

A company who regularly manufactures and services this type of equipment shall offer the controller or I/O system and all of the corresponding components.

Vendor needs to be certified under the ISO 9001-2000 guidelines.

BID ITEM LIST
04-0120S4

Item No.	Item Code	Item Description	Unit of Measure	Estimated Quantity	Unit Price	Item Total
41	014834	RECONSTRUCT ROCK SLOPE PROTECTION (FACING, METHOD B)	M3	5		
42	152386	RELOCATE ROADSIDE SIGN-ONE POST	EA	6		
43	152387	RELOCATE ROADSIDE SIGN-TWO POST	EA	1		
44	152430	ADJUST INLET	EA	1		
45	014835	RELOCATE FIRE HYDRANT	EA	1		
46	153103	COLD PLANE ASPHALT CONCRETE PAVEMENT	M2	50		
47	153210	REMOVE CONCRETE	M3	54		
48	153225	PREPARE CONCRETE BRIDGE DECK SURFACE	M2	1022		
49	014836	PREPARE CONCRETE PAVEMENT SURFACE	M2	240		
50	153229	REMOVE CONCRETE BARRIER (TYPE K)	M	600		
51	157561	BRIDGE REMOVAL (PORTION), LOCATION A	LS	LUMP SUM	LUMP SUM	
52	157562	BRIDGE REMOVAL (PORTION), LOCATION B	LS	LUMP SUM	LUMP SUM	
53	160101	CLEARING AND GRUBBING	LS	LUMP SUM	LUMP SUM	
54	190101	ROADWAY EXCAVATION	M3	4580		
55	014837	ROADWAY EXCAVATION (TYPE H)	M3	460		
56 (S)	190110	LEAD COMPLIANCE PLAN	LS	LUMP SUM	LUMP SUM	
57 (F)	192003	STRUCTURE EXCAVATION (BRIDGE)	M3	10 485		
58 (F)	014838	STRUCTURE EXCAVATION (DUCT BANK)	M3	2190		
59 (F)	014839	STRUCTURE EXCAVATION (TYPE H) (DUCT BANK)	M3	451		
60 (S-F)	192023	STRUCTURE EXCAVATION (TYPE H)	M3	266		

Item No.	Item Code	Item Description	Unit of Measure	Estimated Quantity	Unit Price	Item Total
141	014850	CHAIN LINK FENCE, AND GATE (TYPE CL-2.4, BLACK VINYL-CLAD) WITH BARBED WIRE EXTENSION	M	50		
142	820107	DELINEATOR (CLASS 1)	EA	45		
143 (S)	832002	METAL BEAM GUARD RAILING (STEEL POST)	M	50		
144	833080	CONCRETE BARRIER (TYPE K)	M	510		
145 (S-F)	041521	BIKEPATH RAILING	M	275		
146	041522	REMOVABLE CONCRETE COUNTERWEIGHT (BIKEPATH)	LS	LUMP SUM	LUMP SUM	
147 (S)	839584	ALTERNATIVE IN-LINE TERMINAL SYSTEM	EA	1		
148 (S)	839631	CRASH CUSHION MODULE, SAND FILLED	EA	14		
149 (F)	839717	CONCRETE BARRIER (TYPE 732 MODIFIED)	M	1818		
150 (S)	840515	THERMOPLASTIC PAVEMENT MARKING	M2	74		
151 (S)	840561	100 MM THERMOPLASTIC TRAFFIC STRIPE	M	1510		
152 (S)	840563	200 MM THERMOPLASTIC TRAFFIC STRIPE	M	270		
153 (S)	840564	200 MM THERMOPLASTIC TRAFFIC STRIPE (BROKEN 3.66 M - 0.92 M)	M	100		
154 (S)	014851	100 MM YELLOW THERMOPLASTIC TRAFFIC STRIPE	M	1690		
155 (S)	014852	75 MM BLACK THERMOPLASTIC TRAFFIC STRIPE	M	2330		
156 (S)	014853	100 MM THERMOPLASTIC TRAFFIC STRIPE (BROKEN 10.28M - 4.26M)	M	5470		
157 (S)	840666	PAINT PAVEMENT MARKING (2-COAT)	M2	4		
158 (S)	850101	PAVEMENT MARKER (NON-REFLECTIVE)	EA	1560		
159 (S)	850111	PAVEMENT MARKER (RETROREFLECTIVE)	EA	640		
160 (S)	014854	UNDERGROUND (ELECTRICAL DUCT BANK)	LS	LUMP SUM	LUMP SUM	

Item No.	Item Code	Item Description	Unit of Measure	Estimated Quantity	Unit Price	Item Total
181	014872	150 MM COMPRESSED AIR PIPE	M	290		
182 (S-F)	014873	SERVICE PLATFORM	EA	6		
183		BLANK				
184	015897	FURNISH POLYESTER CONCRETE OVERLAY (19mm)	M3	5		
185	015898	PLACE POLYESTER CONCRETE OVERLAY (19mm)	M2	257		
186	999990	MOBILIZATION	LS	LUMP SUM	LUMP SUM	

TOTAL BID FOR COST: _____

TOTAL BID FOR TIME= _____ **\$50,000.00 :** _____
WORKING DAYS BID **COST PER DAY**

(Not to exceed 900 days on Designated Portion of Work 1)

TOTAL BID FOR BID COMPARISON (COST PLUS TIME): _____