February 6, 2019

California American Water
511 Forest Lodge Rd, Suite 100
Pacific Grove, CA 93950
ATTN: Donald Monette
Jay V. Drewry
Email: donald.monette@amwater.com
Jay.Drewry@amwater.com

Re: **ASR 5 & 6, Above Ground Facility; HHCI Clarification**
Response due: February 6, 2019 at 4:00 PM

Dear Mr. Monette and Mr. Drewry,

Thank you for your consideration of Hal Hays Construction, Inc. (HHCI) for this key project. We consider it an honor to support California American Water.

Per your request, attached are the clarifications for Fitch Park ASR Wells 5 & 6, Above Ground Facility.

Offeror Information

Address	4181 Latham Street, Riverside, CA 92501		**License #**	667560
Tax ID #	54-2084366		**Phone** **Estimating Fax**	(951) 788-0703 (951) 289-7112

Persons Authorized to Negotiate

Names & **Titles**	Kirby Hays, President/CEO Reza Afshar, Civil Estimator		**Emails**	khays@halhays.com rafshar@halhays.com

If you have any questions regarding this proposal, please feel free to contact us.

Best regards,

Kirby S. Hays
CEO
Hal Hays Construction, Inc.
khays@halhays.com

CAW Monterey Peninsula Water supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities
Seaside, CA
Table of Contents

1. BID FORM: Bid Item 2, is to be applied ***only to*** the ***remainder of the design services that are not included in bid items, 1,3-42.*** Provide a cost estimate for bid item 2 as described below in 3.

HHCI confirms that Bid Item 2 applied only the remainder of the design services that are not included in bid items 1, 3-42. Below is a summary of those activities as required by Scope of Design Services (SDS) as follows:

Design costs carried in item #2:

- SDS A.6: Total interaction with all utility companies.
- SDS A.7: Determine all necessary permits and prepare applications – *except Building Code Review is in Bid Item 4*.
- SDS A.8: Preparation of preliminary budget construction cost estimate.
- SDS A.9 and Appendix H: Preparation of Design Memorandum with a 15% Design, provided as Draft and Final, with updates to the Design Memorandum throughout the design.
- SDS A.10: Preparation of a narrative description of operations as an extension to the Design Memorandum (functional descriptions)
- SDS C.2: Shop drawing and approvals including review and approval of resubmittals, and maintenance of shop drop log indicated dates received returned and status. *Assumed 24-electrical and 30-other submittals and resubmittals.*
- SDS C.3: Preparation of supplementary detailed working drawings, specifications, and written instructions throughout construction. *Assumed 12-Electrical RFIs, and 15-civil/ mechanical/ structural/ architectural RFIs.*
- SDS C.5: Provide the services of the Design Project Manager/Engineer during startup, at least five (5) days. Allow ten (10) site visits for Engineers from all other engineering disciplines to resolve start-up issues. *Assumed 5 Days for Civil Engineer, 10 Visits for Electrical Engineer, 3 Visits for Architect, 1 Visit for Structural.*
- SDS C.8: Provide services of Design Project Manager for one (1) days on a twelve months anniversary inspection with written report summarizing warranty repairs and any operational modifications recommended to optimize performance.
- Agreement Section 14.08-B: SRF Funding Reimbursement Technical Assistance. *Assumed 2 hours per month throughout design and construction.*
- Project Management and QA/QC: *Assumed 1 hour per week and 1 hour per each major deliverable.*

2. BID FORM: Bid Item 66, is intended for the contractor to price the two electrical buildings for site ASR 5 and ASR 6. The contractor has changed the quantity from 2 to 1 in your proposal. It should remain as a quantity of 2. Indicate unit price for each electrical building, and for the total of two buildings.

It is confirmed that the price in bid item # 66 covers both buildings. Please see attachment 1 for an updated price sheet.

3. DESIGN PROFESSIONAL SERVICES COST ESTIMATE: Provide a professional services cost estimate of the design services including itemizes Task, Task Description, Hourly Rate, Professional Classification, estimated hours for completion of the tasks, and cost for each line item. The dollar amounts for design services are to match the proposal for PF-3, items "a, b, c, d".

Please see attachments 2a, 2b & 2c for Task Breakdown, Hourly rate, professional classification, estimated hours for completion of the tasks, and costs for each line item. There is a supplemental task description document that elaborates on what is included with each design task.

4. PROPOSAL FORM PF-3 "e": **All items "a, b, c, and d" on this for are for design services/pre-construction services during design, and are compromised of bid items 1-42. Total construction cost "e" is to be entered on form PF-3, as the total of bid items 43-73.**

Please see attachment 3, updated PF-3. The reason that in the original proposal, the difference between items a + b+ c + d and items 1-42 was $346,977 is because the "30% contingency" cost requirement was spread through items a-d, and was added as a line item at that bottom of the overall price sheet. Updated PF-3 now shows the actual design price (which matches 1-42), and adds the 30% contingency on the side.

5. CONTRACTOR'S EQUIPMENT MANUFACTURER'S LIST: Bid addendum 3 required the list of the major equipment that contractor intended in the bid price. This had not been provided. Review the attached list of Cal Am equipment; circle the choice of equipment, and that equipment only on the list. Return the list you have selected.

Please see attachment 4, circled list of major equipment included in the bid price.

6. LIST OF DRAWINGS (DRAWING INDEX): Prepare the required list of drawings anticipated for the project in a drawing index. Approximately 80-90 drawings are required for this project. Justify your index necessary so that the reviewer understands your intent for scope design services.

Please see attachment 5, Drawing Index from HHCI's DOR, LSCE. This list of 80 design drawings encompasses the project scope of work. Additionally, it is anticipated that key subconsultant, Telstar Instruments, will provide 8-10 detailed shop drawings to supplement the design drawings pertaining to their scope of work.

7. LIST OF CSI SPECIFICATIONS: Prepare a list of CSI specifications that are anticipated for this project. See attached CSI list of specifications, review and delete by cross-out, any inappropriate specifications, and if necessary why a specification is not applicable.

Please see attachment 6, Modified/Red-lined List of Project Specifications from HHCI's DOR, LSCE.

8. SDS-10: See attached copy of the scope of work requirements that were included in the RFP. Initial each page at the bottom as confirmation that you are providing the required scope of work. If you have exceptions, provide clear explanations.

Please see attached initialed sheets (Attachment 7).

9. Bid ADDENDUM 3: Provide the list of SCADA/instrumentation equipment you have selected for the project. This list was required as part of the proposal. Circle the equipment for this project from the list, and return the list. Do not remove any pages.

Please see attachment 8, circled list of SCADA/Instrumentation equipment included in the bid price.

10. BID ADDENDUM 3: Select one of the two system integrators: either Telstar or Controls System West. This selection was required as part of the proposal.

HHCI selects Telstar as the System Integrator for this project.

11. BID ADDENDUM 5: Provide confirmation that you bid offer includes the Allen Bradley 18 PWM VFD per addendum 5. Provide the option as described for the active front-end drive as an option items 1-17 are provided in the bid price.

Confirmed. HHCI's price includes the Allen Bradley 18PWM VFD per addendum 5. The option for the active front-end drive needs to be explored further, and will be as part of the design efforts, however, we can confirm that the price for this option will not exceed the price as currently specified.

Please see attachment 9. For a general comparison between the Allen Bradley 18 PWM VFD and Active Front-End (AFE) Drives as well as responses to option items 1-17.

Additionally, it was confirmed during this RFI process that Allen Bradley inadvertently failed to include pricing for the specified enclosure as well as the required spare parts list for the project. Their pricing has been updated to reflect this (Bid Item #69).

12. SCHEDULE: The schedule is not acceptable. However, your schedule will be revised if your proposal is accepted.

Understood.

13. GENERATOR: Provide the required information per Bid Addendum 5.

Generator - We will keep the generator within the following parameters with all loads considered for this project:
Engine HP under 82% utilization
Alternator harmonics below 7%
Voltage dip <10% during ramping
Voltage regulation at <1% during steady state operation.
FYI: This yields a 900kw unit with 1000kw alternator. Not sure what was assumed for the proposal.

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 1: **Bid Form**

MONTEREY PENINSULA WATER SUPPLY PROJECT 10/20/2018
ASR 5 AND 6 - DESIGN BUILD Rev. 0
ABOVE GROUND FACILITIES PROJECT

BID ITEM	APPROX. QTY.	UNIT	DESCRIPTION WITH UNIT PRICE (PRICE IS INCLUSIVE OF ALL APPLICABLE TAXES, PROFIT, INSURANCE, BONDS AND OTHER OVERHEAD)	UNIT PRICE	TOTAL ITEM PRICE
PREDESIGN/DESIGN SERVICES					
1	1	ALLOW	Community Outreach	$7,000.00	$7,000.00
2	1	LS	Design Services (Part III. Scope of Design Services, SDS 1-10)	$202,325.00	$202,325.00
3	1	LS	Dust and Noise Control Plan & Implementation	$14,120.00	$14,120.00
4	1	LS	Building Code Review, Procedures & Plan	$5,325.00	$5,325.00
5	1	LS	Mobilization, Security Fencing, Access Plan	$65,060.00	$65,060.00
6	1	LS	Temporary Power Plan	$3,200.00	$3,200.00
7	1	LS	DUPLICATE- Mobilization, Security Fencing, Access Plan, etc.		$0.00
8	1	LS	SWPPP/Erosion & Sediment Control Plan	$22,215.00	$22,215.00
9	1	LS	Environmental Requirements {Permits 2.7.3)	$3,100.00	$3,100.00
10	1	LS	AVETTA Certification (2.7.3)		$0.00
11	1	LS	Utility Potholing & AutoCAD Mapping	$5,000.00	$5,000.00
12	1	LS	Staking/Surveying Plan, Mapping, & Implementation	$35,000.00	$35,000.00
13	1	LS	Geotechnical Investigations & Borings, Soils Report (2 Sites)	$22,300.00	$22,300.00
14	1	LS	Demolition of Existing Structure Plan	$1,500.00	$1,500.00
15	1	LS	Traffic Control Plans & Implementation	$6,700.00	$6,700.00
16	1	LS	Acceptance Testing Plan & Implementation(2.7.4)	$2,000.00	$2,000.00
17	1	LS	Quality Management Plan (Design & Construction, (2.7.5)	$3,500.00	$3,500.00
18	1	LS	Materials Testing Plan (e.g. Concrete & Soils)	$67,110.00	$67,110.00
19	1	LS	Pump Test Plan & Performance Testing	$1,025.00	$1,025.00
20	1	LS	DELETED PER ADDENDUM 4		$0.00
21	1	LS	Inspection & Test Procedures & Plan	$16,125.00	$16,125.00
22	1	LS	Factory Acceptance Testing/Designer Inspections, (SDS-9)	$12,805.00	$12,805.00
23	1	LS	Operations & Maintenance Training (2.7.6)	$4,000.00	$4,000.00
24	1	LS	Installation Operation, & Maintenance Manual (IOM), Scanned pdf & CD,	$1,100.00	$1,100.00
25	1	LS	Start-Up & Commissioning Procedures Plan	$11,625.00	$11,625.00
26	1	LS	Facility/Utility Shut-Down Plan	$2,010.00	$2,010.00
27	1	LS	Warranty & Acceptance Test Plan	$9,860.00	$9,860.00
28	1	LS	CSI format Technical Specifications (16 Divisions)	$58,650.00	$58,650.00
29	1	LS	Assess Validity, Evaluate, Analyze Accuracy of Preliminary Design	$16,320.00	$16,320.00
30	1	LS	Architectural Drawings/Renderings for Agency Approvals	$63,890.00	$63,890.00
31	1	LS	Civil Drawings, Auto Cad, Full and Half-Sizes	$52,100.00	$52,100.00
32	1	LS	Mechanical Drawings, Auto Cad, Full and Half-Sizes	$56,385.00	$56,385.00
33	1	LS	Electrical & Drawings, Auto Cad, Full and Half-Sizes	$99,280.00	$99,280.00
34	1	LS	Plumbing Drawings, Auto Cad Full and Half-Sizes	$9,450.00	$9,450.00
35	1	LS	Instrument Drawings, Auto Cad Full and Half Sizes	$39,350.00	$39,350.00
36	1	LS	HVAC Drawings, Auto Cad, Full and Half Sizes	$12,315.00	$12,315.00

37	1	LS	Process (P& ID) Drawing Updates, Add Disinfection, Auto Cad, Full/Half Sizes	$60,300.00	$60,300.00
38	1	LS	As-Built Drawing & Conformed Drawings in Auto-CAD	$42,950.00	$42,950.00
PROJECT MANAGEMENT/CONSTRUCTION MEETINGS/REVIEWS					
39	1	LS	Design Meetings (10)	$32,700.00	$32,700.00
40	1	LS	Construction Meetings (24)	$65,300.00	$65,300.00
41	1	LS	Constructability Review (3)	$9,415.00	$9,415.00
42	1	LS	Value Engineering (3)	$14,180.00	$14,180.00
PROCUREMENT/CONSTRUCTION					
43	1	LS	Mobilization/demobilization, Phase 1	$131,000.00	$131,000.00
44	1	LS	Mobilization/demobilization, Phase 2	$255,000.00	$255,000.00
CIVIL/MECHANICAL/PROCESS					$0.00
45	1	LS	Site Preparation for Phase 1 Well Drilling (2 Sites)	$79,100.00	$79,100.00
46	1	LS	Site Preparation, All other work, Phase 2	$125,340.00	$125,340.00
47	1	LS	On-Site Drainage Percolation System, Infiltration Tests	$62,825.00	$62,825.00
48	1	LS	AC Pavement and Subgrade (Tech, Req, Appendix 1)	$193,740.00	$193,740.00
49	1	LS	Site Access & Perimeter Chain Link Fencing, & 7 ft. height, Double Gates (both sites)	$76,505.00	$76,505.00
50	1	LS	ASR Underground Pipeline connections to General Jim Moore Blvd at ASR 5 and 6 (Sheet I-1, Appendix 1)	$319,190.00	$319,190.00
51	1	LS	ASR Above Ground Piping/Valves (Sheet I1 G1, M1 Appendix 1)	$235,650.00	$235,650.00
52	1	LS	Cla-Val Valves, remote controlled, fusion bonded epoxy coating in/out, 110V solenoid manual override, stainless steel trim, indicating limit switches, pilot strainer, open/close speeds, isolation cocks (Tech Req, G1, M1 Appendix 1)	$119,830.00	$119,830.00
53	1	LS	Flow meters, Sparling 656 Tigermag magnetic, local display plus remote transmission 4-20 mA output, polyurethane liner, bidirectional rate and bidirectional totalizing functions (Tech Req, Appendix 1)	$61,080.00	$61,080.00
54	2	EA	Pump water flush lube system, real time flow measurement and lube line differential pressure instrumentation, with interlock shutdown of well pump upon loos of low or pressure in lube line (Tech Req, Appendix 1)	$20,680.00	$41,360.00
55	1	LS	DUPLICATE - ASR Underground Pipeline connections to General Jim Moore Blvd at ASR 5 and 6 (Sheet I-1, Appendix 1)		$0.00
56	1	LS	DUPLICATE - ASR Above Ground Piping/Valves (Sheet I1 G1, M1 Appendix 1)		$0.00
57	1	LS	Isolation Valves, (with manual operators larger than 8" diameter)	$11,215.00	$11,215.00
58	2	EA	DELETED PER ADDENDUM 4		$0.00
59	2	EA	DELETED PER ADDENDUM 4		$0.00
60	2	EA	DELETED PER ADDENDUM 4		$0.00
61	1	LS	Complete Chemical Offloading Facility for bulk sodium hypochlorite deliver off-loading, with wash-down pad sized for WB-50/5,000 gallon storage tanker truck, local control panel, audible alarm, and warning lights, sump, and sump pump and underground chemical resistant storage tank 1000 gal., Compressed air supply to pressurize truck and offload chemical, Operator Interface Panel with level indicator for chemical level in bulk tank, safety showers (2), eyewash stations (2), chemical injecting quills, and injecting ports with static mixers for hypochlorite injection (at ASR 5 SITE ONLY.)	$29,560.00	$29,560.00

62	1	LS	Complete Disinfection Process Faculty for Sodium Hypochlorite system (12.5% solution strength), assume dosing up to 3 mg/l, storage of 30 days supply of bulk storage, FRP bulk storage tank, (2) day tank, (2) bulk transfer pumps, (2) chemical metering pumps, piping and valves, and ancillary equipment. Note a P & ID has not been completed. Contractor shall attach proposed P & ID with the bid for approval. Assume double containment for all chemical storage and dispensing equipment (at ASR 5 SITE ONLY).	$134,525.00	$134,525.00
Structural/HVAC					
63	1	LS	Complete ASR 6 Electric/Controls Bldg. 380 sq. ft. interior minimum, Removable Sound Attenuation Enclosure around pump, non-combustible CMU with Concrete Plank Roof, UBC Type U Building Classification, Mediterranean style, similar to ASR 3 & 4 (Appendix 1)	$370,000.00	$370,000.00
64	1	LS	Complete ASR 5 Electric/Controls Bldg. (min interior 350 sq. ft.) and Disinfection Bldg. (min. interior 650 sq. ft.). interior minimum, Sound Attenuation Enclosure around pump, non-combustible CMU with Concrete Plank Roof, UBC Type U Building Classification, Mediterranean style, similar to ASR 3 & 4 (Appendix 1)	$676,980.00	$676,980.00
65	2	EA	Complete HVAC, Air Conditioning with Economizer mode systems each for Electrical/control Building (Tech Req, Appendix 1)	$46,160.00	$92,320.00
Electrical					
66	2	LS	Complete Electrical Systems, for NEC calculated full-load amperage (FLA) of 1282 amperes, which includes pump, & misc. auxiliary loads, as shown in "Table MSB & Feeder Load Schedule" on Drawing E-1. Panels sizes for 1600-ampere meter/main	$428,062.50	$856,125.00
67	2	EA	Short Circuit and Arch Flash Studies, developed per Cal Am standards, and PGE system data (Appendix 1, 3, 4).Layout per Dwg E-2, Appendix 1.	$10,200.00	$20,400.00
Instrumentation/Controls					
68	2	EA	Complete control system, functionality including start, stop, speed control of the pumps, based on either flow or pressure set point, or manual adjustment. actuation of the Cla Val process valves, Alarm, warning and shutdown interlock functions, record and store process operational data, communicate with main Cal-Am SCADA system, PLC with 10% spare digital I/O, local control panel (LCP), (Tech Req, Drawing I-1, Appendix 1)	$28,130.00	$56,260.00
69	2	EA	Variable Frequency Drive (VFD), indoor NEMA 1G, 18 pulse PWM, No bypass, Heavy Duty Service (50 C rated), dv/dt output filter, Allen Bradley Power Flex 755	$329,695.00	$659,390.00
70	2	EA	Programmable Logic Controllers, Allen Bradley only. PLC program and OIP screens programmed to control the pumps and show booster and well pump operation, status, and alarms, indicated in Tech requirements and on P & ID, Appendix 1	$31,085.00	$62,170.00
71	2	EA	Data System to Transmit Data via SCADA to Cal Am's central Office in Pacific Grove via cellular modem.	$18,880.00	$37,760.00
72	2	EA	Local Operator Interface Panel (OIP), on front of each control panel. PLC program and OIP screens programmed to control the pumps and show booster and well pump operation, status, and alarms, indicated in Tech requirements and on P & ID, Appendix 1	$14,270.00	$28,540.00
73	1	LS	Differential Pressure Transmitters, and pressure transmitters, heat traced and mounted in O'Brien instrument enclosures All transmitter tubing shall be heat traced	$32,340.00	$32,340.00
			Subtotal		**$ 5,924,795**
			Contingency	30%	$ 1,777,439
					$ 7,702,234

OPTIONS

OPTION ITEM	APPROX. QTY.	UNIT	DESCRIPTION WITH UNIT PRICE (PRICE IS INCLUSIVE OF ALL APPLICABLE TAXES, PROFIT, INSURANCE, BONDS AND OTHER OVERHEAD)	UNIT PRICE	TOTAL ITEM PRICE
1	1	ALLOW	Restore concrete curb and gutter at bike path	$8,000.00	$8,000.00
2	1	LS	Construct 10x10 Restroom Building at ASR-5 Site	$110,122.00	$110,122.00
			Subtotal		**$ 118,122**

VALUE ENGINEERING

VE ITEM	APPROX. QTY.	UNIT	DESCRIPTION WITH UNIT PRICE (PRICE IS INCLUSIVE OF ALL APPLICABLE TAXES, PROFIT, INSURANCE, BONDS AND OTHER OVERHEAD)	UNIT PRICE	TOTAL ITEM PRICE
1	1	LS	Deduct if able to remove 30% Design Deliverable (plans / specs) and meeting	-$33,000.00	-$33,000.00
2	1	LS	Deduct if able to reduce the number of Design Meetings from 10 to 5 meetings	-$13,500.00	-$13,500.00
3	1	LS	Deduct if able to reduce the number of Construction Meetings the Designer is required to attend from 24 to 12 meetings	-$20,000.00	-$20,000.00
4	1	LS	Deduct if able to reduce Electrical Engineer site visits during Start-up from 10 to 5 site visits	-$9,500.00	-$9,500.00
			Subtotal		**$ (76,000)**

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 2a: **DOR's Breakdown Summary**

Hal Hays Construction, Inc
Owner: California American Water
Project: Design-Build FP ASR Wells 5

Date: December 7, 2018

Cost of Service Proposal

HHCI's OH+P

Task	Billing Level	LSCE					SUB CONSULTANTS					DIRECT EXPENSES		TOTALS (Engineers)	TOTALS (HHCI's PH+P)	TOTALS
		Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Copies / Reproduction			
	Billing Rate ($/Hr)	$225	$210	$170	$145	$140	Lump*		Lump*	Lump*	Lump*	Incurred	Incurred			
A. Preliminary Design up to and Including Issuing of the Design Memorandum	**LSCE (hours) LSCE (cost) Subconsultant Direct Expenses**	30 $6,750	140 $29,400	90 $15,300	110 $15,950	210 $29,400	$50,084	$20,500	$9,289	$20,973		$1,500	$2,000	**580** **$96,800** **$100,846** **$3,500**		
	Subtotals													**$201,146**	**$30,172**	**$231,318**
B. Preliminary Design Completion through Final Design Phases	**LSCE (hours) LSCE (cost) Subconsultant Direct Expenses**	40 $9,000	280 $58,800	113 $19,210	230 $33,350	300 $42,000	$84,351	$28,939	$13,498	$46,800		$1,000	$5,000	**963** **$162,360** **$173,588** **$6,000**		
	Subtotals													**$341,948**	**$51,292**	**$393,240**
C. Construction/Operation Phase	**LSCE (hours) LSCE (cost) Subconsultant Direct Expenses**	8 $1,800	390 $81,900	60 $10,200	160 $23,200	100 $14,000	$94,051	$39,434	$3,450	$18,078		$4,150	$1,500	**718** **$131,100** **$155,013** **$5,650**		
	Subtotals													**$291,763**	**$43,649**	**$335,412**
Total LSCE Hours		**78**	**810**	**263**	**500**	**610**								**2261**		
Total LSCE Cost		**$17,550**	**$170,100**	**$44,710**	**$72,500**	**$85,400**								**$390,260**		
Total Sub-Consultant Cost							**$228,486**	**$88,873**	**$26,237**	**$85,851**	**$0**			**$429,447**		
Total Direct Expenses Cost												**$6,650**	**$8,500**	**$15,150**		
													COST OF SERVICE PROPOSAL - TOTAL	**$834,857**	**$125,113**	**$959,970**

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 2b: **DOR's Breakdown by Tasks**

Hal Hays Construction, Inc
Owner: California American Water
Project: Design-Build FP ASR Wells 5

Cost of Service Proposal

A. Preliminary Design up to and including issuing of Design Memorandum

Task Items	LSCE					Sub-Consultants					Direct Expenses		
Billing Level	Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Reproduction	
Rate	$225	$210	$170	$145	$140	Lump*	Lump	Lump*	Lump*	Lump*	Incurred	Incurred	
Team Members	B. Gustavson T. Elson	J. Shobe J. Coleman	P. L'Amoreaux	K. Miller	A. Cronk G. Garrison	Frisch Engineering	Telstar	William Merkel Associates					Cost Total
Brief critique of design	5	8	8	8		$3,100			$1,277				$4,377
Initial Conference (mtg #1)	5	8				$2,250					$250		$2,500
Initial Utility Interactions		4		8									
Permit Requirements Review		4		8									
Design Basis Memorandum - Draft	2	10	12	10					$1,429				$1,429
15% Plans	2	8		10	60	$8,500		$1,380	$2,600			$500	$12,980
15% Review (mtg #2)	2	8							$2,410		$250		$2,660
Design Basis Memorandum - Final	2	8	6	8		$2,754			$483				$3,237
30% Plans and Specs	2	12	32	8	70	$5,180		$4,025	$3,530			$750	$13,485
30% Review (mtg #3)		8		10		$3,250			$1,932		$250		$5,432
60% Plans, Specs & Estimate	2	10	32	16	80	$21,800		$3,884	$5,380			$750	$31,814
60% Review (mtg #4)		8		8		$3,250			$1,932		$250		$5,432
Value Engineering Review (mtg #5&6)	5	10		8							$500		$500
SRF Funding Techncial Assistance		16		8									
Project Management and QA/QC	3	18											
Total LSCE Hours	30	140	90	110	210								
Total LSCE Cost	$6,750	$29,400	$15,300	$15,950	$29,400								$96,800
Total Sub-consultant Cost						$50,084	$20,500	$9,289	$20,973				$100,846
Total Direct Costs											$1,500	$2,000	$3,500
TOTAL													**$201,146**

B. Preliminary Design Completion Through Final Design Phases

Task Items	LSCE					Sub-Consultants					Direct Expenses		
Billing Level	Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Reproduction	
Rate	$225	$210	$170	$145	$140	Lump*	Lump	Lump*	Lump*	Lump*	Incurred	Incurred	
Team Members	B. Gustavson T. Elson	J. Shobe J. Coleman	P. L'Amoreaux	K. Miller	A. Cronk G. Garrison	Frisch Engineering	Telstar	William Merkel Associates					Cost Total
90% Plans, Specs	8	48	48	48	176	$36,541		$6,670	$23,400			$2,500	$69,111
90% Review (mtg #7)		16		16							$250		$250
Utility Service Apps (w, ss, st, e)		12		30		$1,600		$1,380					$2,980
Building Permit Review		12		20									
DDW Drinking Water Review		16		26									
Environmental Review		2		12									
Fire Permit Review		2		12									
Meeting to Review Permits (mtg #8)		16		14							$250		$250
Value Engineering (mtg #9)		16		9							$250		$250
Functional Description	20	48		12									
Testing and Warranty Plans			17	5		$23,180							$23,180
100% Plans, Specs & Estimate	8	48	48	10	124	$23,030		$5,448	$23,400			$2,500	$54,378
100% Review (mtg #10)		28		12							$250		$250
SRF Funding Techncial Assistance				4									
Project Management and QA/QC	4	16											
Total LSCE Hours	40	280	113	230	300								
Total LSCE Cost	$9,000	$58,800	$19,210	$33,350	$42,000								$162,360
Total Sub-consultant Cost						$84,351	$28,939	$13,498	$46,800				$173,588
Total Direct Costs											$1,000	$5,000	$6,000
TOTAL													**$341,948**

C. Construction/Operation Phase

Task Items	LSCE					Sub-Consultants					Direct Expenses		
Billing Level	Principal Professional	Supervising Engineer	Project Engineer	Staff Engineer	AutoCAD Drafter	Electrical Engineer	Instrumentaion Engineer	Structural Engineer	Building Architect	Acoustical Engineer	Travel	Reproduction	
Rate	$225	$210	$170	$145	$140	Lump*	Lump	Lump*	Lump*	Lump*	Incurred	Incurred	
Team Members	B. Gustavson	J. Shobe	P. L'Amoreaux	K. Miller	A. Cronk G. Garrison	Frisch Engineering	Telstar	William Merkel Associates					Cost Total
Construction Meetings (x24 mtgs)		200				$16,870					$3,040		$19,910
Review of Shop Dwg (x50 submittals)		16	40	80		$24,687		$2,012					$26,699
Supplementary Design Information		16	12	32	30	$11,247							$11,247
FAT Inspection Services		16		4		$6,377							$6,377
Startup - Design Engineer (5 Days)		40									$860		$860
Speciality Sub Startup (10 Days)						$29,488		$1,438					$30,926
Record Drawings		20		16	70	$5,382						$1,500	$6,882
O&M Manuals		20	8	16									
1-year Anniversary Inspection		10									$250		$250
SRF Funding Techncial Assistance				12									
Project Management and QA/QC	8	52											
Total LSCE Hours	8	390	60	160	100								
Total LSCE Cost	$1,800	$81,900	$10,200	$23,200	$14,000								$131,100
Total Sub-consultant Cost						$94,051	$39,434	$3,450	$18,078				$155,013
Total Direct Costs											$4,150	$1,500	$5,650
TOTAL													**$291,763**

California American Water
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Attachment 2c: **Item D Breakdown**

Hal Hays Construction, Inc
Owner: California American Water
Project: Design-Build FP ASR Wells 5 & 6

Cost of Service Proposal

HHCI's OH+P

Task	Billing Level	HHCI						SUBCONTRACTOR		DIRECT		TOTALS (HHCI, Direct Cost)	TOTALS (HHCI's PH+P)	TOTALS
		Project Executive	Project Manager	Project Superi	Project Engineer	Estimator	Scheduler	Electrical		Travel	Copies / Reproduction			
	Billing Rate ($/Hr)	$148	$128	$120	$85	$128	$120	Lump*	Lump*	Incurred	Incurred			
d. Pre-construction Services during Design Phase	**HHCI's Hours**	140	560	140	340	96	80					**1356**		
	Direct Expenses	$20,720	$71,680	$16,800	$28,900	$12,288	$9,600	$4,500		$4,200	$2,012	**$159,988** **$4,500** **$6,212**		
	Subtotals											**$170,700**	**$25,920**	**$196,620**

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Attachment 3: **Updated PF-3 (For Item 4)**

this summary form has been revised. DRMonette

Proposer has not sought by collusion to obtain for itself any advantage over any other Proposer or over Owner.

P-4 CONTRACT PRICE

4.01 Proposer will complete the Work in accordance with the Contract Documents for the following price(s):

A. COST OF THE WORK

1. The Cost of all Work other than Unit Price Work shall be determined as provided in Paragraph 10.01 of the General Conditions, as revised or amended by the Supplementary Conditions and shall include the following amounts subject to increases or decreases for changes in Work as provided for in Article 8 of the Agreement

2. Lump Sum Fees

a. Design Professional Services - Preliminary Design up to and Including Issuing of the Design Memorandum.

$ 300,713.00 = $231,318 + 30% Contingency $69,395

b. Design Professional Services – Preliminary Design Completion through Final Design Phases.

$ 511,212.00 = $393,240 + 30% Contingency $117,972

c. Design Professional Services – Construction/Operational Phase

$ 436,035.00 = $335,412 + 30% Contingency $100,623

d. Pre-Construction Services during Design Phase

$ 255,607.00 = $196,621 + 30% Contingency $58,986

e. **Total construction costs: includes Bid Form,** Construction Supervision and Superintendence.

$ 6,198,666.50
= $4,768,205 + 30% Contingency $1,430,461.50

f. Cost of Bond Premiums (Based on construction estimate):

$ 57,267 = $44,051.5 + 30% Contingency $13,215.5

Premium unit Price $ 8.00 /$ 1,000.00

Range: $ 4,000,000.00 to $ 8,000,000.00

TOTAL LUMP SUM (a. + b. + c. + d. + e. + f.):

$ 7,759,500.50
= $5,968,846.5 + 30% Contingency $1,790,654

California American Water
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Attachment 4: **Elect Equip List**

Revised 3-23-2018; KEL

Equipment Description	Manufacturers
LV Power Distribution Equipment – (Swgr, Swbds, Panelboards, Circuit Breakers, etc)	Cutler-Hammer Square D ABB Siemens General Electric
Transformers – Dry Type, VPI, VPE Insulation	Cutler-Hammer Square D/Sorgel Siemens ABB
Transformers – Cast-Coil	Square D/Sorgel ABB
Transformers – Liquid-Filled	*Not Preferred Equipment*
Protection Relays & Monitoring Relays for Voltage, Current, Phase Loss, Etc.	SEL (Schweitzer Engineering Laboratories) *Other acceptable manufacturers may include the following (subject to prior approval by AW Engr / Owner)* All to be provded with Fiber-Optic Communications over Ethernet / Modbus TCP/IP
Power Quality Metering, Motor Monitoring & Feeder Protection Relays	SEL 735, SEL 710, SEL 751A, SEL-489 Other SEL devices as applicable for the design of the power distribution system. *Communications to utilize fiber-optic interface; dual-port for loop configuration where available. Copper communications to be utilized only where specifically indicated. All to be provded with Fiber-Optic Communications capability Ethernet / Modbus TCP/IP and DNP3*
Low Voltage Motor Control Centers	Cutler-Hammer Square D ABB Siemens General Electric
Full Voltage Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric
Reduced Voltage (Solid-State, Soft Start) Motor Starters	Cutler-Hammer Square D ABB Siemens General Electric Danfoss Benshaw

Equipment Description	Manufacturers
Low Voltage Variable Frequency Drives – Stand Alone Applications (Free-Standing or Wall Mounted Units) *NOTE: Basic Criteria - All VFD equipment to be "Heavy Duty" / "Industrial Duty", rated for 50 C. and suitable for full load rating with 3% voltage unbalance. Cooling fans shall be accessible without requiring total dismantling of the drive assembly; top outlet discharge preferred.* *"HVAC Rated" Drives are Not Permitted* *** NEMA4X Note: Drive assembly to be rated NEMA 4x by manufacturer; use of open chassis or NEMA 1 drives installed in NEMA 4x enclosure is not suitable in meeting this criteria.*	Free-Standing – Wall or Floor Mounted Square D Cutler-Hammer Allen Bradley Toshiba ABB Siemens/Robicon Danfoss Benshaw Yaskawa NEMA 4X Type (where required)** Allen Bradley Yaskawa T B Woods Others as determined suitable for the application Harmonic Filters (where required) TCI Mirrus MTE NO IN THIS PROJECT
Low Voltage Variable Frequency Drives – Part of MCC Lineup/Equipment *(Not an AW preferred method)*	Cutler-Hammer Square D ABB Seimens General Electric
Low Voltage Automatic or Manual Transfer "Switches" – Contactor Type assembly NO IN THIS PROJECT	ASCO 4000 Series (unless otherwise suitable) Other potential Suppliers include: Cutler-Hammer GE/Zenith Russelectric
Low Voltage (*Service Entrance Rated where applicable*) Automatic Transfer Equipment (Circuit Breaker Transfer Equipment – Manual or Automatic) *NOTE: Circuit Breaker – Main and Circuit Breaker – Standby (where identified) REQUIRED unless specifically accepted otherwise*	Cutler-Hammer/Eaton Square D ASCO 4000 Series Russelectic Switchgear General Electric NOT IN THIS PROJECT
Uninterrupted Power Supplies	APC Powerware General Electric Mesta Liebert MCG

Equipment Description	Manufacturers
Surge Protective Devices (UL-1449, Rev 4 Compliant and **Listed/Labeled**) *Note: use of integral SPD with panelboards and equipment not permitted; provide stand-alone external devices only unless otherwise specifically approved*	APT – Advanced Protection Technologies "XDS" Series MCG Cutler-Hammer "SPD" Series
NOTE: The following descriptions provide general guidelines for lighting fixtures and applications. As LED technology continues to be available at lower costs, American Water recommends evaluation between LED and Fluorescent lamps/fixtures. Where fluorescent fixtures are used (T-5 and T-8 fluorescent lamps), provide Programmed / Rapid-Start Ballasts. (*note- the use of Instant-Start ballasts is prohibited*) The use of LED technology is recommended for all exterior applications unless special aesthetic and/or other site-specific criteria is established by the Owner or Regulatory Authority	
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Enclosed and Gasketed Fluorescent for Damp and Wet Locations (Process and Chemical Rooms)	EPCO GFF Series w/SS Latches, Simkar EN 2 or 3 w/SS Latches, Holophane ERS Series, Lithonia FSW or FHE Series, ILS Others as accepted by Owner *(Note – the use of fixtures similar to Lithonia DMR Series, Columbia LUN Series, Simkar OV450, etc are generally prohibited due to on-going physical / performance issues associated with this type of design (limited latches retaining sealed integrity of the assembly)). Fixture selection is to take into consideration lamp output, lumen maintenance, and environmental factors associated maintainability of the overall system.*
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor dry applications	Benjamin, Philips, Keene, Lithonia and Others as accepted by Owner
Lighting Fixtures – Fluorescent T-8 lamps, Program-Start Ballasts, Indoor Hazardous Locations	Appleton Crouse-Hinds Killark Others as accepted by Owner
Lighting Fixtures – LED Indoor	Lithonia Philips Cree Others as accepted by Owner
All LED luminaires must be UL Listed (e.g. UL8753 / UL8750) and tested to IESNA LM-79 and LM-80 standards and that the results of those tests must be submitted to the Owner as part of the submittal review process. LED fixtures to be provided with a minimum 5 year warranty covering the driver, the LED components and the luminaire.	
Lighting Fixtures – LED Outdoor	RAB Cree Philips Dialight Lithonia Others as accepted by Owner
Lighting Fixtures – HPS Outdoor	Holophane, Infranor Devine, Philips Others as accepted by Owner

Equipment Description	Manufacturers
Lighting Control - Occupancy Sensors	Sensor Switch (High Humidity / Low Temperature Type) – process & chem. Areas Leviton, Hubbell, P&S along with others mfgrs and products to be provided as determined suitable for the location and environment where installed. *NOTE: Technology (passive IR, ultrasonic, or dual) to be based on location where installed.*
Lighting Control – Daylight Harvesting and/or Special Function and Dimming	Lutron Wattstopper Day Light Controls Others as accepted by Owner
Control and Timing Relays ("Ice-cube" relay style)	Diversified Potter Brumfield Syrelec Allen Bradley Square D Cutler-Hammer Seimens Releco Others as accepted by Owner
Push Buttons, Selector Switches & Pilot Lights (30 mm minimum size devices, NEMA 4X style preferred and high-intensity LED pilot lamps)	Cutler-Hammer Square D Seimens Allen Bradley Kraus & Naimer
Definite Purpose Relays and Contactors	Cutler Hammer Square D Siemens Allen Bradley
PVC Coated Rigid Steel Conduit	Ocal Robroy
Fiberglass Conduit	Champion FRE
Power Generation Equipment – (Diesel engine driven units)	Onan/Cummins Caterpillar Kohler Others only as determined accepted by Owner
Industrial and Corrosion Resistant Wiring Devices	Cooper Industries Legrand Leviton Hubbell Meltric Woodhead, http://www.woodheadsales.com

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Attachment 5: **CAW Item 6 Drawings**

LIST OF DRAWINGS

Sheet	Drawing	Title
GENERAL		
1	G01	TITLE SHEET AND LOCATION MAP
2	G02	INDEX OF DRAWINGS
3	G03	ABBREVIATIONS, NOTES AND SYMBOLS
CIVIL		
4	C01	OVERALL SITE PLAN HORIZONTAL CONTROL – ASR 5
5	C02	OVERALL SITE PLAN HORIZONTAL CONTROL – ASR 6
6	C03	PHASE 1 SITE PREPARATION PLAN – ASR 5
7	C04	PHASE 1 SITE PREPARATION PLAN – ASR 6
8	C05	PIPING PLAN – ASR 5
9	C06	PIPING PLAN – ASR 6
10	C07	GRADING AND DRAINAGE PLAN – ASR 5
11	C08	GRADING AND DRAINAGE PLAN – ASR 6
12	C09	CUT/FILL SECTIONS – ASR 5
13	C10	CUT/FILL SECTIONS – ASR 6
14	C11	SOIL EROSION & SEDIMENT CONTROL PLAN – ASR 5
15	C12	SOIL EROSION & SEDIMENT CONTROL PLAN – ASR 6
16	C13	EROSION CONTROL DETAILS
17	C14	FENCE DETAILS
18	C15	CAWC STANDARD DETAILS I
19	C16	CAWC STANDARD DETAILS II
20	C17	CAWC STANDARD DETAILS III
21	C18	CIVIL DETAILS III
22	C19	CIVIL DETAILS IV
23	C20	CIVIL DETAILS V
MECHANICAL		
24	M01	WELL HEAD AND STATION PIPE PLAN – ASR 5
25	M02	WELL HEAD AND STATION PIPE PLAN – ASR 6
26	M03	CHEMICAL/CONTROL BUILDING ARRANGEMENT - ASR 5
27	M04	CONTROL BUILDING ARRANGEMENT - ASR 6
28	M05	BUILDING PLUMBING PLAN - ASR 5
29	M06	BUILDING PLUMBING PLAN - ASR 6
30	M07	BUILDING HVAC PLAN - ASR 5
31	M08	BUILDING HVAC PLAN - ASR 6
32	M09	CHEMICAL DETAILS – ASR 5
33	M10	ANALYZER STATION DETAILS – ASR 5 & 6
34	M11	WELL COMPLETION DETAILS - ASR 5 & 6
35	M12	SOUND ENCLOSURE DETAILS - ASR 5 & 6
36	M13	MECHANICAL DETAILS I
37	M14	MECHANICAL DETAILS II
38	M15	MECHANICAL DETAILS III
STRUCTURAL		
39	S01	STRUCTURAL GENERAL NOTES & DETAILS
40	S02	FOUNDATION PLAN - ASR 5
41	S03	FOUNDATION PLAN - ASR 6
42	S04	PARAPET ROOF PLAN & DETAILS - ASR 5
43	S05	PARAPET ROOF PLAN & DETAILS - ASR 6
44	S06	STRUCTURAL DETAILS I
45	S07	STRUCTURAL DETAILS II
ARCHITECTURAL		
46	A01	ARCHITECTURAL NOTES & DETAILS
47	A02	FLOOR PLAN - ASR 5
48	A03	FLOOR PLAN - ASR 6
49	A04	EXTERIOR ELEVATIONS - ASR 5
50	A05	EXTERIOR ELEVATIONS - ASR 6
51	A06	FINISH SCHEDULE AND DOOR SCHEDULE - ASR 5 & 6
52	A07	DOOR AND WINDOW DETAILS I
53	A08	ARCHITECTURAL DETAILS I
54	A09	ARCHITECTURAL DETAILS II

Sheet	Drawing	Title
ELECTRICAL		
55	E01	ELECTRICAL SYMBOLS AND ABBREVIATIONS
56	E02	ONE-LINE DIAGRAM AND ELEVATION – ASR 5
57	E03	ONE-LINE DIAGRAM AND ELEVATION – ASR 6
58	E04	PANEL SCHEDULES
59	E05	ELEMENTARY DIAGRAM – ASR 5
60	E06	ELEMENTARY DIAGRAM – ASR 6
61	E07	PLC CONTROL PANEL LAYOUT
62	E08	PLC CONTROL PANEL WIRING DIAGRAM I
63	E09	PLC CONTROL PANEL WIRING DIAGRAM II
64	E10	PLC CONTROL PANEL WIRING DIAGRAM III
65	E11	VIDEO MONITORING SYSTEM CONTROL DIAGRAM
66	E12	PUMP ENCLOSURE POWER PLAN
67	E13	PUMP ENCLOSURE LIGHTING AND RECEPTACLE PLAN
68	E14	CHEMICAL BUILDING POWER PLAN
69	E15	CHEMICAL BUILDING LIGHTING AND RECEPTACLE PLAN
70	E16	SITE ELECTRICAL PLAN - ASR 5
71	E17	SITE ELECTRICAL PLAN - ASR 6
72	E18	ELECTRICAL DETAILS I
73	E19	ELECTRICAL DETAILS II
INSTRUMENTATION		
74	I01	INSTRUMENTATION SYMBOLS AND ABBREVIATIONS
75	I02	WELL SYSTEM P&ID - ASR 5 & 6
76	I03	CHEMICAL FEED SYSTEMS P&ID - ASR 5
77	I04	MISCELLANEOUS SYSTEMS P&ID
78	I05	COMMUNICATIONS BLOCK DIAGRAM
79	I06	INSTRUMENTATION DETAILS I
80	I07	INSTRUMENTATION DETAILS II

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Attachment 6: **CAW Item 7 Specs**

* = optional Section, info can be included in other sections

Add Sections:
02825 Site Security Fencing

Redundant, covered under Division 3 and plan details

Modify for "Vertical Turbine Pumps - DB Components"

Add Sections:
13224 Sodium Hypochlorite Tank
13230 Chemical Feed Equipment

Typically combine into two sections
15025 Pipe (Station, Distribution, and Drainage)
15110 Valves and Related Appurtenances

Where is pressuer sustaining valve ?

DIVISION 16 - ELECTRICAL

Replaced with Sections:

California American Water
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Attachment 7: **Scope of Design Services – Initialed**

III. SCOPE OF DESIGN SERVICES

A. Design Professional Services- Preliminary and Final Design

Design Professional Services shall include the work described in General Conditions 6.01 as amended by the Supplementary Conditions and work described in this Scope of Design Services including all listed Attachments.

Review of the design will be performed by American Water engineering personnel. Any changes in the scope of services during the design phase must be addressed by the Design/Builder before the work is performed. Changes will be made in accordance with Articles 3 and 11 of the General Conditions.

1. Preparation of a brief critique of the design concepts to determine what modifications to the concepts may result in a more cost effective project, simplified construction, and/or improved operating procedures. This document shall be submitted prior to the initial design meeting.

2. Attendance at periodic meetings with the Owner at their site located in **Pacific Grove, CA**. At least ten (10) working days shall be allotted in the schedule for review of information by Owner prior to any meeting. It is expected several one-day meetings (unless otherwise noted) will be required during the design phase including:

    1. An initial conference (this will include review of the design critique and alternative concepts and be coupled with a one day partnering meeting mentioned below and in Supplementary Conditions SC-2.05 Initial Conference),
    2. Two meetings to review the instrumentation requirements (these will be coupled with the 30% and 60% design review meetings),
    3. Meetings to review the progressive completion at (15%, 30%, 60%, 90%, and 100%) of design drawings and specifications and to prepare for permit submittals. The draft Design Memorandum will be submitted for review prior to the 15% meeting. The final Design Memorandum and preliminary drawings will be reviewed at the 30% meeting.

    The Design Builder is responsible for preparing notes summarizing the discussions and the conclusions from the meetings and distributing the notes within 7 days following the meeting.

    The preliminary design phase will be considered complete at the 60% completion of design and upon Owner's approval of the construction cost estimate.

3. All land survey work as necessary to adequately complete the design and file permit applications and provide reference points for construction layouts. As a minimum, property lines, topographic information and location of existing structures are to be included.

4. All geotechnical investigations including soil borings, rock cores, and auger probing as necessary to adequately complete the design and estimate and plan construction earthwork.

5. All environmental activities as necessary to adequately complete the design and file permit applications.

6. Total interaction with all utility companies to design and specify proper service for the proposed improvements and to coordinate the relocation of existing utilities as required. The Design/Builder shall also determine if any additional capital or usage fees will be imposed by any specific utility.

7. Determine which Local, State, and Federal permits are required for the facility, prepare the necessary applications, and provide technical input as required in securing these permits. The Design/Builder shall also provide Owner with information regarding the approximate length of review time for each permit, and any special requirements that could delay this process (e.g., public hearings). When required by the permitting agency, the permit applications will be formally submitted by Owner.

8. Preparation of a preliminary budget construction cost estimate broken down by major work item, and a detailed construction cost estimate breakdown: (labor, materials, equipment, subcontract, temporary construction etc.) organized by Construction Specifications Institute (CSI) division and major process components. The preliminary estimate is to be submitted with the Design Memorandum. The detailed construction estimate is to be submitted in accordance with the Supplementary Conditions SC-6.01 Design Professional Services.

9. Preparation and maintenance of a Design Memorandum. The Design Memorandum is a summary of design data presented in outline format along with other pertinent project information. The primary intent of the memorandum is to allow Owner to review and comment on the design before the Design/Builder proceeds with detailed design and drafting. The memorandum shall be updated throughout the design and submitted to the Owner with each set of updated drawings. A summary of the information to be included in the memorandum is outlined in the Attachments. After completion of the draft Design Memorandum a meeting (15% completion) will be held with all parties. The purpose of the meeting will be to review the Design/Builder's Design Memorandum to determine and evaluate alternative concepts to reduce capital and operating costs and/or to improve operations. The Design Memorandum will be modified with the results of this evaluation by the Design/Builder.

10. Preparation of a narrative description of the operation of the proposed facilities to be used by plant operations personnel to familiarize themselves with the operation, capabilities, and limitations of the proposed improvements. The narrative shall be an extension of the process sections from the Design Memorandum, but in text format. It shall explain the intent and function of each unit process in addition to the system as a whole, and it shall include the detailed written control strategies (functional descriptions), which were prepared for the Design Memorandum submission. Preparation of the narrative shall not begin until the Design Memorandum is finalized and accepted. The narrative shall be submitted as a separate document for review at the final design review meeting. It shall serve as the foundation of the Operations and Maintenance Manual discussed in the Construction/Operation Phase section of this document.

11. Preparation of a complete and coordinated set of design drawings for all engineering disciplines with an adequate level of detail to allow for review/approval by permitting agencies and construction by the Design/Builder. Drawings used for permit applications and bidding require the signature and seal of a licensed professional engineer in the State of California. The drawing sets require segregation by major discipline: site, architectural, structural, mechanical, electrical, instrumentation, etc. Drawings shall not contain extensive notes and written instructions that are more appropriate for the specifications. Standard detail drawings shall exclude items that are not applicable to the current project.

    The Design/Builder shall prepare all drawings using the most current version of AutoCAD for Windows. The Owner will not accept drawings created in an alternative CAD program, such as MicroStation, and "converted" to AutoCAD format. The Design/Builder shall use only AutoCAD and AutoLISP routines and no vendor-furnished or third party programs.

    PLEASE REFER TO AMERICAN WATER DRAWING STANDARDS AND SAMPLES.

    It is recommended that the Design/Builder submit an early review (e.g., 15 percent complete) set of .dwg files for this project. The Owner shall review the .dwg files for conformity with the Owner's AutoCAD standards and advise the Design/Builder of any necessary changes. The Owner then shall assume that the Design/Builder completes the remainder of the design in conformity with the Owner's AutoCAD standards. If it is later found that final documents do not conform, the Design/Builder shall revise the final .dwg files at the Design/Builder's cost. The Design/Builder shall have the opportunity to discuss the Owner's AutoCAD standards with Company staff.

    Standards developed by the Owner, and applicable to this project, and selected drawings of the existing facilities are provided in the Attachments. The information provided in the record drawings may not represent actual field conditions. The Design/Builder has the responsibility to field verify and record the existing conditions as necessary to complete the design phase.

    Electrical drafting symbols shall conform to IEEE Standard 315 and 315A. Specific requirements for the design of instrumentation and controls for water treatment processes or water distribution, where applicable, are:

    a. Conduct on-site investigations, interface with process engineers/designers, and review design materials and drawings to determine the type and location of primary sensors, control devices, panels and related instruments, and control equipment. The locations, elevations, and mounting details for these devices shall be included on the drawings.

    b. Prepare P&ID drawings in accordance with ISA Standard S5.1 and Remote Terminal Unit (RTU) Interconnection drawings (input/output point lists) from the P&IDs. Example RTU Interconnection drawing and an electronic template will be provided to the selected Design/Builder upon request. The RTU interconnection drawings must be sufficiently detailed and accurate such that they can be utilized by the System Integrators and provided back to the Owner as record drawings. The Design/Builder is responsible for allowing each of the pre qualified System

Integrators identified by the Owner to review the RTU Interconnection drawings prior to the final design review meeting. The minimum information to be included on the RTU Interconnection drawings is as follows:

- Wiring from field instruments to the appropriate I/O point on the RTU.
- All signal isolation and signal conditioning equipment as required (e.g., a current to current isolator).
- Connections associated with the communications between RTUs (radios, fiber optic modems, etc.).
- Contacts and coils on digital outputs.
- Wiring tags showing the RTU number, I/O type (AI, AO, DI, DO), RTU card number, and I/O point number.
- Connections for DC power supplies.

c. Prepare ladder logic diagrams to show the hard wired logic in panels and motor control logic in PLCs. Drawings shall be prepared to show the general configuration of all new panels, consoles, and the wiring between interconnected hardware components.

d. Prepare conduit and wiring drawings showing conduit and signal wire routing using scaled base drawings of all facilities. Where appropriate, the conduit and wiring drawings shall be integrated into the electrical drawings.

12. Preparation of technical specifications, Divisions 2 through 16 in the CSI Spec-Text format, and the list of required shop drawings, in final electronic form for printing, copying, and binding by the Design/Builder. Specifications shall reflect only the scope of work for the current project. Standard specifications shall be modified to exclude items not applicable to the current project.

    Specifications shall be prepared using the most current version of the Microsoft Word for Windows word processor. If your standard specifications are in a format other than Microsoft Word, they must first be converted to Microsoft Word format, thoroughly checked to ensure that a complete conversion was accomplished (including all tables, charts, headers, footers, etc.), then edited for this project as appropriate within Microsoft Word. The text shall be 11 point Arial font. An electronic file name for each specification section shall include a descriptive name preceding a 5-digit specification section number followed by the Microsoft Word file extension (e.g., PROJECT 11500.doc).

    The American Water System Construction Contract Documents prohibit a Design/Builder from submitting substitute or "or equal" materials or equipment when a proprietary product, named manufacturer, or supplier has been specified. Provisions exist for bidders to submit alternatives to these items at bid time only. To ensure competitive pricing is being obtained for material and equipment that is not necessary to be a sole source item, it is recommended that at least three (3) acceptable manufacturers or products be listed in the specifications for each of these items. Specifying less than three (3) manufacturers is acceptable only when approved by the Owner in cases where the products of additional manufacturers are not deemed to be comparable or do not meet the project requirements. If design details have been used on the drawings that are based on one of the listed products,

this should be noted in the specifications. If design revisions are necessary to accommodate the other acceptable products, additional details shall be provided for the other products to facilitate complete and accurate bidding. Where an item is to be furnished on a sole source basis, only one (1) acceptable manufacturer or product will be listed in the specifications. If common items are included in multiple specification sections, language is to be included in the specifications that the same manufacturer is to be used for these common products.

In general one of the two specification methods above shall be used for all process, mechanical, and electrical equipment and other materials that are unique to the design (e.g., certain piping, valve, structural, mechanical, electrical and architectural products). Specifications for other materials or products that can be written prescriptively, by performance, or by reference to applicable standards, do not need to include specific manufacturers or products unless desired by the Design/Builder or the Owner.

The specific items and requirements of the specifications for the electrical control circuits and the instrumentation and controls for water processes or water distribution, where applicable, are listed below. The Design/Builder shall interface closely with the Owner in the development of these items.

a. Specifications for the digital equipment, and field and panel mounted instruments. Communication protocol between control system equipment and other digital equipment shall be specified by the Design/Builder and verified that it is compatible with the DCS. Data to be transferred by serial communications with other digital equipment shall also be identified.

b. An input/output point list.

c. Instrument specification sheets that are in accordance with ISA Standard S20.

d. Detailed written control logic and strategies (functional descriptions). Identification of the initial set points to be used at startup when variable set points are required in the control strategy shall also be identified.

e. Graphic display descriptions. Each specific display shall be identified and a brief description provided. Each I/O point (or calculated value) that should appear on each display must also be identified (preferably by indicating the name or number of the display directly on the I/O list). Sample displays, which will be provided by the Owner, shall be included in the contract documents.

f. Report definitions. All typical reports that the Owner will generate shall be integrated with the control system and be accessible via an electronic spreadsheet (Microsoft Excel) or electronic database (Microsoft Access). The Owner will provide examples of each specific report that shall be provided in the specifications. The I/O point or tag number that corresponds to each entry space in each report shall be identified directly on the example reports with appropriate instructions such as whether the data is an average, taken at a specific time of the day, etc. Entry spaces that the system cannot accommodate and need to be filled in manually shall be identified as such.

g. Alarming strategies for all alarms conditions including both warning alarms and critical alarms. Warning alarms are defined as analog (or calculated) alarms that provide notification that a critical condition is being approached (e.g. high turbidity, low chlorine residual, etc.). Critical alarms initiate automatic action by the system to address a critical condition (e.g. shut down the facility, start a backup piece of equipment, etc.). The specific action associated with each critical alarm shall also be identified. The Design/Builder shall identify all initial alarm set points to be used at startup.

h. Structured Query Language (SQL) database definition. All analog values, integrated values, and other relevant historical data shall be identified by the Design/Builder for inclusion in the SQL database and trending by the Systems Integrator. The Integrator shall store all historical data in a Microsoft SQL Server format.

i. Narrative descriptions of all pump control circuits (pump starters for example). These descriptions shall describe in detail the operation of these circuits in the various operating modes (manual, auto, remote, etc.) and shall provide information relating to the purpose of each device (relays, timers, lights, etc.) included in the circuit.

13. Provide a total of ten (10) sets of design memoranda, drawings, and specifications to be used during the design period for review purposes prior to each meeting. This same distribution of final drawings and specifications along with all final design information shall be made at the completion of design. Where possible, this information shall be submitted in electronic format. The information shall include all design notes and calculations, the design memorandum, drawings, and specifications. Electronic information, submitted at the end of (or during) the project, shall be on electronic media acceptable to Owner. Provide one set of full-size plans at the completion of final design phase, along with an electronic PDF format set.

14. Performance of a constructability and Value Engineering review by the Design/Builder with participation of Owner. Review each element of construction work with consideration given to feasible methods of construction, constraints to construction (materials, labor, specialty construction, weather, plant operations, other, etc.), design details, time required to complete each element of work, and possible alternatives which would reduce costs.

B. Pre-Construction Services

Pre-Construction Services shall include but not be limited to the following:

1. Make arrangements, schedule, chair and take minutes for all meetings during the design phase portion of the project.

2. Preparation and maintenance of a progress schedule throughout the duration of the design and construction phases is required. The schedule requirements are described in the General Conditions and Section 1300 of the Specifications. The initial schedule for this project must focus on completing work necessary to file the

necessary permit applications and procurement of necessary equipment and materials to meet the Contract Times.

3. Preparation and agreement of the Target Cost of Construction. The Target Cost is to be mutually agreed between the Owner and Design/Builder on an open book basis (with costs established upon the principles of Cost of Work under paragraphs 10.01 to 10.03 of the General Conditions) during the course of the design development. Upon reaching stated percentage completion of the design, including reconciliation of Owner's comments, the Design/Builder shall prepare and present the Target Cost for Owner's agreement.

   Target Cost Development:

   General: As a minimum, the Target Cost shall be prepared and presented in general conformance with the Sixteen (16) Division Format of the Construction Specifications Institute (CSI) and/or by Area of Work as defined in the Estimated Cost of Construction template form; the final content and format is to be agreed with the Owner. Full description of the Target Cost arrangement is provided in the Supplementary Conditions and the Agreement.

   A minimum of three (3) quotations or proposal from Owner-approved suppliers, vendors, manufacturers, subcontractors, etc. shall be obtained to set the target cost for all equipment, materials, products, and subcontracted labor and services. Receiving less than three (3) quotations or proposals is acceptable when approved by the Owner or in cases where the products or services of additional or other suppliers, vendors, manufacturers, subcontractors, etc. are not deemed to be comparable or do not meet the project requirements. The lowest responsive quotation or proposal shall be used to set the cost unless approved by the Owner. The cost for self performed work shall be agreed upon pursuant to SC 10.01. An amount for the Design/Builder's risk/contingency may be included as set forth in the Agreement.

   The Design/Builder shall submit the Target Cost to Owner and include a cover letter detailing the basis of the Target Cost, CSI and/or Work Area estimates and all supporting documentation that shall be clearly listed, labeled and itemized.

   Target Cost shall be developed as follows:

   A. Preliminary Target Cost shall be developed at the 30% design completion stage. Quotations and proposals shall be based on and reference the 30% design documents and shall be specific to model, size, material, etc. as applicable. "Budgetary" quotations or proposals may be used to develop costs if the design of that item or discipline has not progressed to the point where more specific quotations or proposal can be furnished.

   B. The Target Cost shall be developed upon completion of the 60% design, including incorporation of Owner's comments. Quotations and proposals shall be based on and reference the 60% design documents and shall be specific to model, size, material, etc. as applicable. The quotations and proposals shall be accurate, complete and remain valid for a minimum of 60 days and be ready for execution by the Design/Builder. "Budgetary" quotations or

proposals may not be used to develop the Target Cost unless approved by the Owner. In such instances, the budgetary quotation may be used as a "place-holder" to assist in setting the Target Cost at the discretion of the Owner and will be subject to revision once appropriate quotations or proposal can be obtained.

4. Preparation of a detailed construction sequence and logistics plan describing how the proposed facilities will be constructed and placed in-service while keeping existing facilities in-service as necessary. The plan shall consider seasonal limitations and shall specifically define all partial or full outages (including electrical) with estimated time for each outage as well as details on proposed time of day (i.e. regular working hours or evening/weekend hours), proposed time of year (i.e. during peak or off-peak demand seasons) and any special precautions, actions, temporary facilities, etc, that shall be required to safely complete each outage. The plan must be reviewed and approved by Owner to ensure that operations of any existing facilities will be properly maintained during construction. The plans are to show, at a minimum, the scheduled completion of construction on a calendar quarterly basis. Cost associated with keeping the plant on-line as a result of this plan shall be included in the Cost of Construction. As a consequence, the detailed construction sequence and logistics plan must be completed as part of the 60% design.

5. Provide constructability reviews at the 15%, 30%, 60%, and 90% of the design development phase. Review each element of construction work with consideration given to feasible methods of construction, constraints to construction (materials, labor, specialty construction, weather, plant operations, etc.) design details, time required to complete each element of work, and possible alternatives which would reduce costs, and maintain the level of quality expected by the Owner.

   The reviews shall include the appropriate designers, the Owner, and subcontractors if required as participants.

   Include providing the net cost and or time savings associated with each suggested change or modification to the design. Maintain a log tracking each suggestion with the results pertaining to cost and or time savings and acceptance/partial acceptance/rejection.

6. Performance of a bidability review with participation of Owner. Review the breakdown of the work into bid packages that will yield the most cost effective construction program with consideration given to the availability of qualified subcontractors and vendors. Develop interest in the project from prequalified subcontractors and vendors.

7. Maintain electronic communication capabilities throughout the design and construction phases of the project.

   The Web browser that you utilize must be capable of handling file attachments, and your e-mail must be MIME (Multipurpose Internet Mail Extensions) compatible in order to send file attachments without the need to encode/decode. Additionally, all electronic data files (word processing documents, spreadsheets, etc.) created by American Water will be prepared using the **2010 version of Microsoft Office**, and the Consultant must have the ability to read these file formats. It is preferred, but not

mandatory, that the consultant also create all data files that may need to be shared via the Web or e-mail in Microsoft Office format.

8. Identify the permits that are required for construction phase of the project, and prepare the necessary applications, and secure these permits. Provide the Owner with information regarding the approximate length of review time for each permit, and any special requirements that could delay this process. Provide all information required for the permit application and submit the fees required. The Owner will reimburse the Design/Builder for all permit application and permit fees at their direct cost. Include but not limited to the Building Permit, electrical, etc. including wastewater discharge if required.

C. Design Professional Services – Construction/Operation Phase

Design Professional Services-Construction/Operation Phase must include the following services:

1. Attendance at construction progress meetings, resolution of construction problems related to the design, and review and interpretation of the design.

2. Shop drawing review and approvals including review and approval of resubmittals, and maintenance of a shop drawing log indicating dates received, returned, and status.

3. Preparation of supplementary detailed working drawings, specifications, and written instructions or meetings as necessary throughout the construction period to interpret the contract plans and documents and to resolve changes brought about by actual field conditions encountered.

4. Provide the services of the I&C Staff Engineer or Subconsultant to witness the factory acceptance test (FAT) of the assembled I&C system prior to the system's shipment from the factory to the job site. The first goal is to ensure that the system has been assembled properly and is in proper working order. This will include testing of each individual I/O point and should be witnessed by the I&C Staff Engineer. The second goal is to simulate and test the control logic, and this portion of the FAT should be attended by the Design Project Manager/Engineer or someone familiar with the details of the process design and operation of the facility. Additionally, provide the services of the I&C Staff Engineer for site visits to review and inspect the instrumentation and wiring of field mounted instruments, resolution of problems, initial calibration and testing, and system start-up.

5. Provide the services of the Design Project Manager/Engineer who will participate in and observe each process and/or phase of initial operation of the project (start-up) and review operation and performance tests required by the contract specifications. At least five (5) days should be allotted for on-site start-up services and resolution of initial operating problems. Engineers from all of the engineering disciplines shall be made available to resolve start-up issues as required, and also to resolve problems which may arise during the construction period allow ten (10) site visits for these services.

6. Preparation and submittal of electronic record drawings within two (2) months after start-up. The record .dwg files shall conform to the Company's AutoCAD standards. If it is found that final documents do not conform to the Company's AutoCAD standards, the Consultant shall revise the final .dwg files at the Consultant's cost. Data, information, sketches and working drawings, to be incorporated with the record drawings, shall be provided by the Design/Builder. The record drawings shall include all above and below grade changes from the original design drawings for all engineering disciplines. Changes made to reflect the as-installed conditions shall be made in the same level of detail and to the same degree of drafting quality as the original design drawings. The I&C engineer must review record drawings prepared by the wiring contractors to verify their accuracy prior to substantial completion. Reference Division 1 of the specifications for additional information.

7. Provide four (4) copies of an operation and maintenance manual containing operating, maintenance, and repair information from manufacturer's submittals. The O&M manual shall also contain the final narrative description of the operation of the proposed facility, and a complete description of start-up and shut-down procedures. The O&M manual shall be bound in 3-ring binders and indexed with tabs according to major process designations in the order of the treatment process. Four (4) complete electronic copies of the final O&M manual shall also be provided on CD. An initial draft of the O&M manual, without manufacturer's data, shall be submitted for review at approximately the 50% point of construction completion. The complete O&M manual containing all manufacturer's data shall be submitted at the 95% point of construction completion but no later than one (1) month before scheduled start-up.

8. Provide the services of the Design Project Manager/Engineer for a one (1) day inspection of the facilities approximately twelve (12) months after they are placed into operation. The Design Project Manager/Engineer shall provide a written report summarizing warranty repairs that are necessary, as well as any operational modifications that are recommended to optimize performance.

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Attachment 8: **Instrumentation List**

3.4 *Power Supplies*: Separate power supplies shall be provided for analog inputs and PLC's, and digital outputs.

3.5 *Conduit Spacing*: Required between power and signal / control cables as listed in the I.E.E.E Standard 518-1982, current edition.

3.6 Signal/Control Wiring for Corrosive Areas

A. *Ammonia*: Use Schedule 80 PVC conduit material for any new wiring required in these areas. Existing conduit and conductors should be reused wherever possible. Where possible, enclosures for control and electrical components should be located outside of the feed rooms. Where this is not possible, the enclosures shall be fiberglass NEMA 4X type enclosures.

3.7 3 - Wire Control: Required for all pieces of equipment (one normally open contact for start and one normally closed contact for stop). Chemical Metering pumps (require one contact for start and stop).

3.8 Modulating Valves: Analog control with full opened / full closed feedback or open / closed control with position feedback and full opened / full closed feedback.

3.9 Analog inputs and outputs shall be 4-20 mA. Discrete Inputs shall be 24 VDC. Isolated dry relay contacts shall be furnished for all Discrete Outputs – relays may be integral to the I/O module. Interposing relays may be furnished in cases where the I/O module relay contacts do not have adequate electrical ratings.

3.10 Input / Output Modules: Provide high density I/O modules.

PART 4 ACCEPTABLE MANUFACTURER'S LIST

SCADA / INSTRUMENTATION

Equipment Description	Manufacturers
Pressure Transmitter	Rosemount (Monterey) Endress Hauser
Turbidimeter	Hach
pH Analyzer NOT USED	Hach Wallace & Tiernan ProMinent
Chlorine Residual Analyzer NOT USED	Hach Wallace & Tiernan

	Prominent
Industrial Ethernet Switch	Hirschmann Stratix
Radio (Licensed and Un-Licensed) **(Not for New Install) NOT USE	Microwave Data Systems (GE MDS)
Antenna (Radio) **(Not for New Install)	Clearwave Samco Andrew Decibel Pctel
Cellular Modem	Sierra Wireless (GX450)
Programmable Logic Controller	Allen Bradley (ControLogix, CompactLogix L3 or Higher)
Fluoride Ion Monitor NO T USE	ABB, ATI Orion ProMinent
Particle Counters/Monitor NOT USE	Chemtrac Systems, Inc. Hach
Streaming Current Detector NOT USE	Chemtrac Systems Inc.
Temperature / ORP Analyzer NOT USE	Emerson ABB ProMinent
Flow Switch	Dwyer Instruments Inc. Flotect Kobold
Venturi Flowmeter NOT USE	BIF Henry Pratt Primary Flow Signal Badger
Magnetic Flowmeter	ABB Rosemount Endress Hauser Sparling TigerMag (Monterey Preferred)
Displacement & Turbine Flowmeter	Sensus Technologies Neptune McCrometer
Ultrasonic Meter NOT USE	Nusonics Division – Mesa Laboratories Polysonics Panametrics
Ultrasonic Level Probe NOT USE	Endress Hauser Inventron Siemens Flowline Ametek – Drexelbrook
Radar Level Probe NOT USE	Endress Hauser Ohmart-Vega

	Siemens Magnetrol
Capacitance Probe NOT USE	Ametek - Drexebrook Siemens
Float Level Switch NOT USE	Siemens Anchor Scientific
Level Instruments – RF Admittance Probe NOT USE	Ametek - Drexelbrook
Auto Dialer *Note: Not for New Installations NOT USE	Raco Verbatim Antx
Ammonia Analyzer NOT USE	Hach ChemScan
PLC Enclosure	Saginaw Control Engineering (SCE) Hoffman Engineering
Human Machine Interface (HMI) Software	ICONICS Gen32 GE Proficy iFix (Sacramento only)

PART 5 SCADA HMI SCREEN AND SYSTEM REQUIREMENTS

5.1 SCADA HMI screen display must include but not limited to the following. *(Set points include; alarm set points, level control set points, process parameters, and various control points.)*

A. Well Sites

a. Well level with alarm set points
b. Well pump motor control and status
c. Chemical analyzer and chemical feed system controls
d. Discharge pressure and flow display with alarm set points
e. Hydro pneumatic tank level and controls (if applicable)
f. Blow valve status and control
g. Totalizer values for flow, runtime and pump starts
h. Well tuning set points
i. Power monitor
j. Trending graph of critical points

B. Booster Pump Stations

a. Pump motor controls and set point
b. Source and discharge tank level display and set points (if applicable)
c. Inlet and discharge pressure with set points
d. Discharge flow and set points (if applicable)
e. Discharge valve control and status
f. Totalizer values for pump runtime and starts

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Attachment 9a: **Addendum 5, Items 1-17**

Cal Am Water
Design Build of Fitch Park ASR Well 5 and 6

Reply to the RFI 11.

1	Our bid includes Allen Bradley 18 Pulse and AFE, Eaton AFE and Schneider AFE VFD.
2	Our bid includes Allen Bradley 18 Pulse and AFE.
3	See attached information from Allen Bradley where they describe drive features specifically designed for operation on Generator.
4	The Generator size is based on the following minimum guidelines: These are specific for this project. Engine HP under 82% utilization Alternator harmonics below 7% with pump running Voltage dip <10% during ramping Voltage regulation at <1% during steady state operation
5	The Drive Cabinet will be designed by the Manufacturer. We do not have much option to relocate components but will work with them to address concerns of CAW. Typically, the drive transformer will be in its own compartment for a drive this large.
6	The VFD can be operated in 40-60 Hz.
7	The power factor (pf) of 18 Pulse VFD is specfied 0.95 or better.
8	Both 18 pulse and AFE VFD comply with IEEE-519-1992
9	Drive is quoted in NEMA 12 as specified.
10	Both VFD are continuous duty 24 hours, 7 days a week.
11	If the cable length is 100 ft or less the dV/dt filter is not needed. The actual cable length in this application, according to Engineer, is about 50 ft.
12	Rockwell Automation/Allen Bradley 18 pulse PWM Powerflex 755 is provided in the bid.
13	Harmonic mitigration: Rockwell/AB will perform harmonic study to sensure it meet IEEE-519 requirement.
14	Power system Analysis: Rockwell/AB will perform power system analysis during preliminary design.
15	2 years waranty parts and labor are included as sepecified.
16	Rockwell Automation/AB includes spare parts as specified.
17	The Rockwell/AB service center is in East Bay which is within 4 hours drive or 200 miles range. The response time is estimated to be 72 hours or less. The per diem charges for an authorized technician is $2,870/8-hour day plus expense. Price list will be proivded upon selection of manufacturer and drive. Drive Manufacturer will provide confirmation of acceptance upon selection of the Drive.
18	The Drive manufacturer will compile to co-ordinate with motor manufacturers to ensure the motor is compatible with the Drive.

Additional information
Comparion of 18 pulse and AFE VFD

	18 pulse VFD	**AFE VFD**
Footprint	101"(H)X25"(D)X220"(W)	79"(H)X27"(D)X80"(W)
Fitting to Bldg	need to enlarge building	Fit to proposed building
Cost	about $5000 more	slightly cheaper
Saving on building	cost of redesign build and construction	Save ten of thousand dollars on engineering and construction.
Thermal energy	more thermal energy (bigger A/C)	less thermal energy (smaller A/C)
Reiability	reliable. In the market for decades	Rockwell states: more reliable than 18 pulse VFD
Maintenance	difficult to work on and replace components	interchangeable parts in cart and can be easily replaced.

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Attachment 9b: **VFD Information**

Selecting the Best Option for Low Harmonic AC Drives

Jeff Raefield, Power Technical Consultant, Rockwell Automation

For decades, the standard solution for mitigating harmonics created by large AC inverter based Variable Frequency Drives (VFDs) to meet the requirements of IEEE-519, has been to utilize a phase shifting transformer based solution that allows the rectifier portion of the VFD to draw power from the line with less harmonic current distortion. This option, referred to as "Multi-Pulse", "18 pulse" or "12 pulse" drive technology, has always presented challenges that until now, had to be lived with. This paper will explore those challenges and present a more modern approach to solving the issue of harmonics in large VFDs, the Active Front End (AFE) drive. Harmonics is a complicated subject deserving of more detailed explanations, but that is not the purpose of this paper. The focus here is on one aspect, how end users, when taking advantage of the other benefits of using VFDs, deal with harmonic distortion they may cause. So we will only address the salient points to help illustrate the issues discussed about the technologies.

Background

Harmonic distortion to the power system created by the advent of "non-linear" loads has been a problem since the invention of the bridge rectifier, but was initially limited to smaller devices such as computer power supplies, DC drives, electronic ballasts and such. The explosion of AC VFDs into the industrial and commercial marketplace beginning in the late 1980s however exacerbated that once minor issue into one of significant importance because it led, in the early years, to problems such as transformer fires, overloaded conductors, equipment damage and significant economic losses. So to help users address this issue more thoroughly, in 1992 the Institute of Electrical and Electronic Engineers (IEEE) issued a revised statement of standards, number 519, for end users and utilities to follow regarding how they can help avoid this problem, not only for themselves, but for their neighbors. This document, ***IEEE-519-1992***, has been the industry standard for addressing this and although updated in 2014, is still considered the best practice in mitigating the issues.

IEEE-519 outlines separate responsibilities for end users and the power utilities that serve them and since this paper is targeted toward the end users, we will focus on that aspect, beginning with a brief overview of what "harmonic distortion" is and why it is important to deal with it.

Harmonics are frequencies superimposed upon the fundamental frequency (60 Hz in North America, 50 Hz in most other countries) that are multiples, called "orders" of that fundamental. So here in NA the "second order" harmonic is 120 Hz (2 x 60), the third is 180 Hz (3 x 60) etc. When their amplitude is the same, harmonics in any two conductors that are *even* orders, meaning an order number divisible by 2, will cancel each other out. Likewise in a 3 phase system, any "triplen" harmonic, meaning divisible by 3 (i.e. 9th, 15th, 21st etc.) are self cancelling. The problematic harmonics are mostly odd orders that are *not* divisible by 3, called the "***non-triplen***" harmonics, so the 5th, 7th, 11th, 17th, etc. It is these non-triplen harmonics that accumulate in the power system, circulate in transformers causing excessive heating, overload conductors and waste energy, as well as risking failure of the power distribution system as a whole. Harmonics can refer to distortion of the Voltage waveform, or the Current waveform, each of which affects the other.

"Thou Shalt Not Mess Up Thy Neighbor's Voltage!"

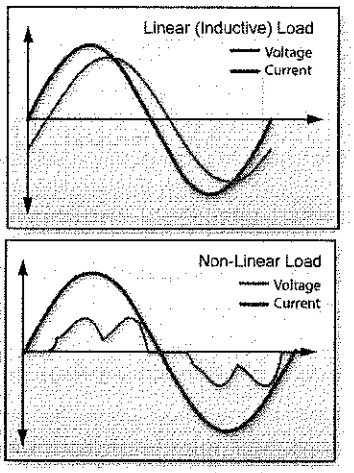
Distortion of the Current waveform is what causes distortion of the Voltage waveform, then having a distorted Voltage waveform can exacerbate Current distortion. But it has to begin with that distortion of the Current waveform, because that is what is related to the WORK being performed at any facility. A simplified way to look at the issue is this:

- Non-linear loads in YOUR facility create harmonic CURRENT distortion.
- Harmonic current distortion in your facility is what causes VOLTAGE distortion
- Voltage distortion can travel, via the utility connections, to your NEIGHBOR's facility.
- Voltage distortion coming INTO any facility can then make CURRENT distortion in that facility worse and the problem can spiral out of control.

So the basic underlying premise for ***users*** in IEEE-519 is that you must do whatever you can to limit the Total Harmonic Distortion of CURRENT (THD-I) that your equipment creates, in order to avoid creating excessive Total Harmonic Distortion of VOLTAGE (THD-V) that might "escape" your facility, travel on the utility lines and affect someone else.

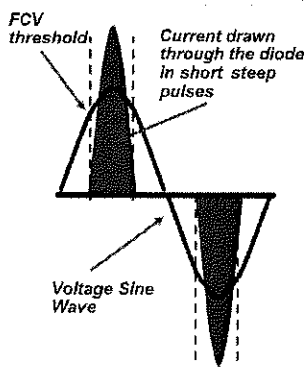
The chief power utility aspect of IEEE-519 is that, because THD-V coming *INTO* a user's facility will exacerbate their THD-I, the utility must ensure that there is a limit to the THD-V in the power they deliver. But remember, the THD-V is not *CREATED* by the utility (for the most part), so the only way they can control this is to impose and enforce rules onto their customers, the users. It then falls upon the utilities to be the ones to monitor their connected customers and insist upon mitigation. That point of measurement is referred to as the "**Point of Common Coupling" or PCC**. They do not, however, dictate HOW mitigation is implemented as they are only interested in the result; the lowest possible THD-V that is passed on to other connected users via their lines.

When to Mitigate



An AC load connected to and drawing current from a source can be considered as having a "linear" or "non-linear" current draw from the source. Linear loads draw current into the device from the source in the same smooth sine wave form as the AC voltage change was taking place. "Linear" loads then are things like resistance heating devices, incandescent lighting, magnetic ballasts, and AC motors that are running Across-the-Line (DOL for those outside of North America). Years ago, most AC loads were linear, hence "harmonics" was virtually unheard of.

Nonlinear loads, as mentioned earlier, are those with rectifiers that create harmonics. Non-linear refers to the way in which the devices draw (pull) current from the source into their rectifier for whatever purpose they are going to use it. As time goes on, more and more of the loads we connect are now considered nonlinear, because ANYTHING with a power supply is a nonlinear load and a lot of our devices are now using power supplies in one form or or another.



When something needs DC power and is fed from an AC source, a **Diode Bridge Rectifier** is often used to convert AC to DC. Diodes conduct in only one direction, hence their use in rectifying. But they do not conduct continuously in that one direction, they have what is called a "Forward Conduction Voltage" (FCV) threshold, below which the diode *doesn't* conduct, above which it *does*. So ***a diode pulls current from the incoming line only at the PEAKS of each sine wave***. This results in a "pulsing" effect on current, which then distorts the voltage sine wave as it happens.

How much distortion takes place has a lot to do with the "stiffness" of the supply source or how much total available current is in the system, meaning what the transformer or generator is capable of delivering with the given impedance on the supply, usually referred to more succinctly as the "Available Short Circuit Current". If you have a very large supply and a very small non-linear load, the effect that one load has on distorting the voltage can be miniscule, whereas a large load can have a more meaningful effect. But the effects are also cumulative, so a large number of small loads can have the same effect as a small number of large loads, and a combination, which is usually the case, can quickly become very problematic.

Determining when mitigation is necessary can be simple if you can just measure the THD at the PCC, but determining in ADVANCE of purchasing new equipment can be difficult. A detailed "Harmonic Study" of all of the relevant factors should be done to be sure and is typically performed by someone with specific knowledge and training in this complex subject. There are also several software based estimators available, in fact Rockwell has some that can be run from Web Based Tools (see appendix for link). But for quick estimating, a simplified "rule of thumb" is as follows:

If the nonlinear load is 20% or higher of the total load in your facility, then you are a good candidate for harmonic analysis and mitigation.

This rule is basically just to determine IF a further study is warranted. But remember, the ONLY loads that are linear now are resistance heating and AC motors running A-T-L. and that ***anything with a power supply is a nonlinear load***. So that includes not only VFDs, but also DC drives, "ECMs" (Electronically Commutated Motors), Servos, PC and PLC power supplies, all forms of monitors and TVs, audio equipment, copiers, printers, UPS systems, battery charges and more recently because of the move away from incandescent lighting, all energy efficient lighting, including HID, Fluorescent, Compact Fluorescent, even LEDs. All these things have what are called "Switch Mode Power Supplies" (SMPS) or something like it and all SMPS create harmonic distortion.

Mitigation Strategies

Once you have determined IF you need to mitigate harmonics, then you must decide on HOW to do that. There are multiple strategies, all valid so long as the end result is achieved; reducing the THD-V at the PCC. But these strategies can be categorized in two main ways;

Mitigate Cumulatively;

If you want to, you can simply look at the total problem, THD-V, at the place it matters, the PCC, and implement a solution there that neutralizes the THD-I to as to control the THD-V. That solution is called an "Active Harmonic Filter" and if the THD-I is relatively low in a facility, this can be a very cost effective approach. But this is not the subject of this paper, except that IF you chose to take that approach, mitigating your larges loads separately can greatly increase the cost effectiveness of this solution.

Mitigate Collectively;

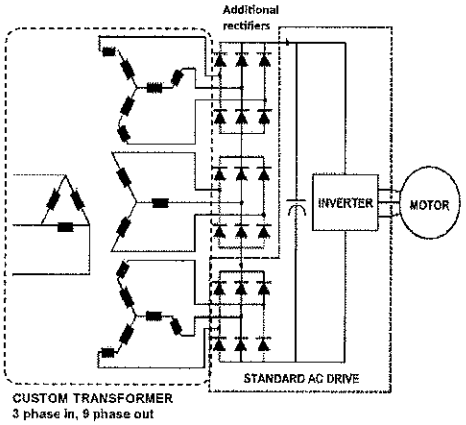
This strategy is based on the precept that if you mitigate each contributor to the problem, you mitigate the total problem because the nature of the problem is ultimately cumulative, so if the contributors are all mitigated, the accumulation is mitigated as well. This of course can become very expensive very quickly as you add harmonic filtering or mitigation systems to each and every nonlinear device in your facility. But the most important aspect of this approach is to mitigate the ***worst offenders*** on that list first, because large VFDs will by definition be a large portion of the nonlinear load profile, making it an important strategy even if you implement an Active Harmonic Filter at the PCC as well.

Large Motor Drive Strategies:

In the collective mitigation approach then, there are two main design strategies for larger drives and are the two that are the subject of this paper; Multi-Pulse Front End drives, which has been the go-to choice for decades, and the newer more modern option, Active Front End (AFE) drives. We will explore these two options in more detail in the following paragraphs.

Multi-Pulse Front End VFDs (18 Pulse)

The strategy behind a multi-pulse front end VFD is to have a custom transformer system that takes 3 phases in on the primary, and has multiple secondaries on the same core, each wound to cause a phase shift relative to the others. For simplicity we will discuss only an 18 pulse design because it is the most prevalent in NA*. So in an 18 pulse drive, that transformer has 3 separate 3 phase secondaries or 9 phases, each shifted from one another by 20 degrees. Each of these 9 phases is connected to two diodes, one for positive, one for negative, hence the 18 "pulses" in how the current is drawn from the line. The phase shifting between these 18 pulses then causes some of the non-triplen harmonics to themselves shift, so some of the 5^{th} becomes 6^{th}, some of the 7^{th} becomes 9^{th} or 10^{th}, some of the 11^{th} becomes 15^{th} or 16^{th}, etc. etc. and because those are now divisible by 2 or 3, they now cancel each other out. Each of the sets of rectifiers then just feeds a common DC bus that goes to the inverter portion and is recreated back to 3 phase to the motor, and the harmonics from creating that DC bus have been mitigated.

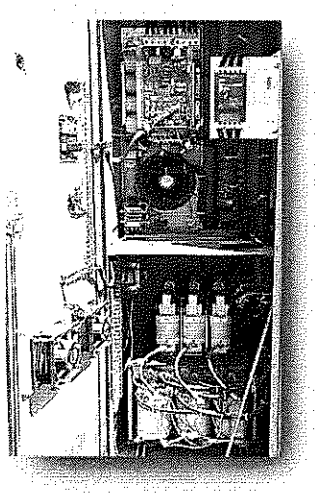


18 Pulse Drive Advantages:

- Familiarity. An 18 pulse VFD is a "tried and true" solution that has been implemented for decades now and is well understood by technicians and support staff.
- The mitigation technology is "passive" in that it is the magnetics of the custom transformer that does the bulk of the work, so there is little impact on the functionality of the VFD itself.
- THD-I created by the VFD system is held to 5% or less**, the most desirable level when considering the effect it might have on the THD-V at the PCC.
- Power factor through the drive is not affected, so it remains at .90 or better.

18 Pulse Drive Challenges;

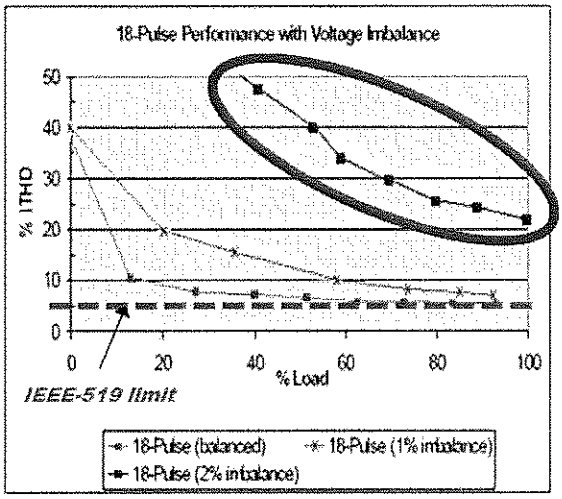
- The transformer is **expensive, large and heavy**, creating challenges at the installation stage if space and maneuverability of a crane is limited. The transformer also presents limitations in conduits can enter and exit.
- The transformer produces **heat** and VFD electronics are sensitive to heat, so keeping an 18 pulse VFD cool can be a challenge, requiring the transformer to be in an adjacent enclosure, increasing the footprint. If space is limited, some manufacturers have chosen to design their drives to minimize floor space by "stacking" the VFD portion on top of the transformer portion. But that then puts the most heat sensitive parts right above the heat generating parts, and since heat rises, it becomes a long term reliability issue.
- The transformers are custom made, so replacements can cause major delays and significant down time.



** 12 pulse designs are more prevalent in countries outside of North America where large loads are few and far between.*

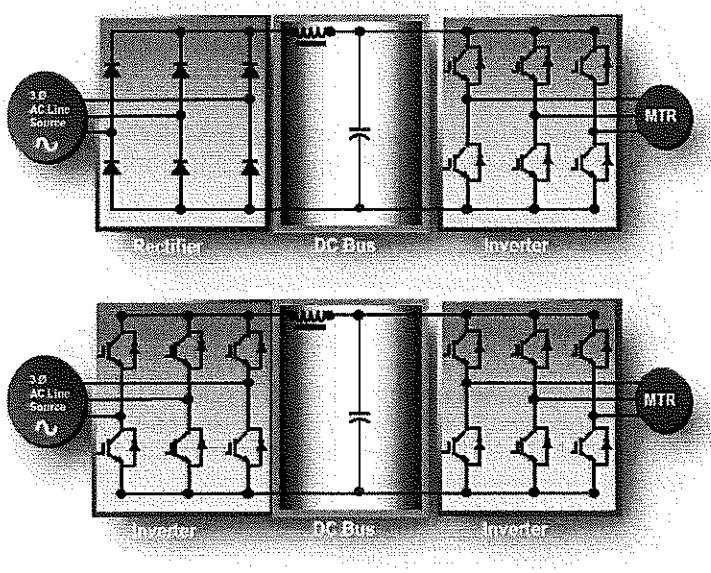
*** 12 pulse typically can only mitigate THD-I to 10-12%*

- Perhaps the biggest challenge, and the "dirty little secret", with 18 pulse drives is the fact that the ***harmonic mitigation suffers if the line voltage is not near perfectly balanced***. This then may result in the fact that you've implemented it and paid for it, but it may not be working as intended! When 18 pulse was the best thing available, this issue was often overlooked (if known about at all) because options were not available *that didn't come with more significant problems*. But studies have shown that at just 1% voltage imbalance between phases, the THD-I mitigation can exceed IEEE-519 recommendations, jumping to as much as 15% THD-I at low load. Worse yet, at 2% imbalance, which is still considered "acceptable" to most utilities, the THD-I can jump to as much as 20% at full load, and 40% THD-I at half load on the drive! This then can cause overheating of the transformer and can also become problems for the diode bridge components. If that transformer fails, you are then faced with that down-time issue in getting a replacement. Yet line voltage balance is usually beyond the control of the end user, it is the result of the utility having to serve multiple customer single phase loads that they have little control over. So what often happens is that an 18 pulse drive is tested and accepted on a good day, then shortly thereafter, the harmonic mitigation is no longer performing, forcing ***the user to FURTHER mitigate, often with ANOTHER strategy such as an Active Filter***, on TOP of the cost of buying the 18 pulse drive.



Low Harmonic Active Front End (AFE) Drives

The AFE drive is not a new concept, they have been used for decades as well, but primarily for line regenerative braking, not for harmonic mitigation. So the only thing that is "new" in the PowerFlex 755TL **Low Harmonic** AFE drive is that they are now being offered for this purpose alone (or combined with line regenerative braking in the PowerFlex 755T**R**). In an AFE drive, the "rectifier" is actually another inverter connected to the LINE side of the drive. This inverter then is an "active" device and the process of rectification is done by the transistors in that front-end inverter. The firing of those transistors is controlled using a special algorithm called "Selective Harmonic Elimination" (S.H.E.) to ***avoid creating*** the 5th, 7th and 11th current harmonic, the ones with the highest amplitude, so that the issues that cause voltage harmonic distortion are avoided in the first place. So an AFE drive is not thought of in terms of a number of "pulses", because in fact it AVOIDS pulses; it is a "pulseless" technology and rather than alter the harmonics as an 18 pulse does, it just never creates very much in the first place.



- As you can see in the diagrams, the Active Front End drive model is almost as if you have two back-to-back VFDs; an inverter that runs the motor, another inverter that interacts with the line as it rectifies the AC to DC.

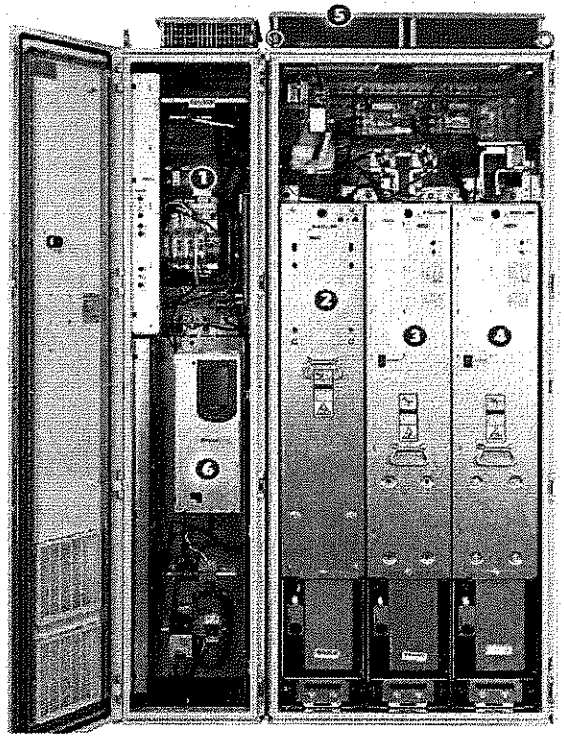
- Not shown in that diagram but very important is that in order to interact with the line source, the drive has to be capable of accurately measuring it first, so there is a lot more sensing of the line taking place than in a standard VFD.

- Also not shown here but equally important is the need for additional line side filtering. As mentioned above, S.H.E. takes care of the bulk of the problem, the 5^{th}, 7^{th} and 11^{th} harmonics. But higher order harmonics, although lower in amplitude, can start to create more EMI and RFI issue. So better designs also add additional line side filtering to capture and mitigate these higher order harmonics.

PowerFlex 755TL AFE drive design

The PowerFlex 755TL Low Harmonic AFE drives 250HP and larger are designed around a "modular" concept where the control and power components are each in their own module within the drive. The modules are;

1. *The Line Disconnect, Circuit Breaker and Pre-charge system that prevents damage to the DC bus capacitors when first energized*
2. *The L-C-L filter module, used to filter out high order harmonics and sense the line side power issues.*
3. *The Line Side Inverter Module that rectifies the AC into DC, eliminating the 5^{th}, 7^{th} and 11^{th} harmonics and conditions the DC bus.*
4. *The Load Side Inverter module that provides the variable frequency / variable voltage AC power out to the motor.*
5. *The ventilation system within each module that takes cooling air into the bottom and channels it through and across the module heat sinks in a dedicated air channel to exit from the top , without mixing that high volume of air with the more sensitive control electronics.*
6. *The "Control Pod" in a separate cabinet (with its own cooling system) that is the brains of the drive and contains the interface for the door mounted HIM, I/O, option and communications boards*



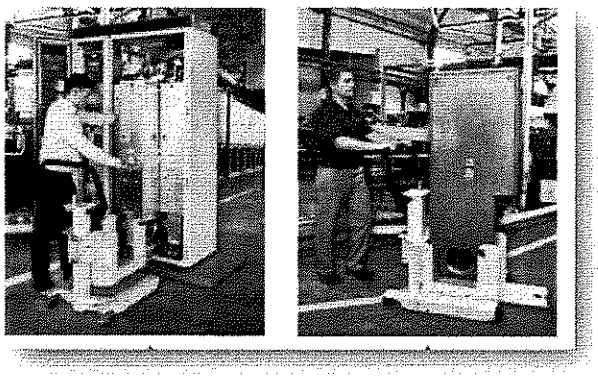
Typical PowerFlex 755TL Frame 8 drive arrangement

As motor power sizes increase, multiple modules of the inverters and/or filters are added in parallel, communicating with each other and the control pod via high speed fiber optics to act as a single unit.

The L-C-L filter and inverter modules are on roll-out chassis for easy servicing and inspection. In addition, the inverter modules are interchangeable, meaning fewer spare parts are required for low down time in the event of an issue.

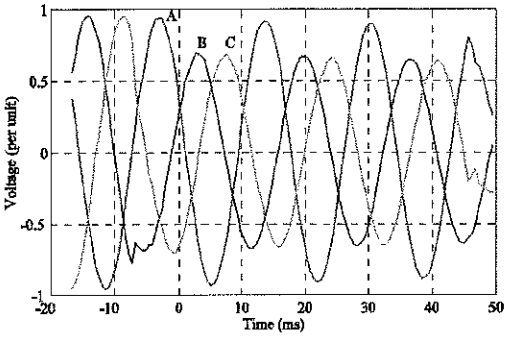
Cooling fans for the power modules are independently located in each power module and can be removed for servicing or replacement from the front with a simple thumb screw.

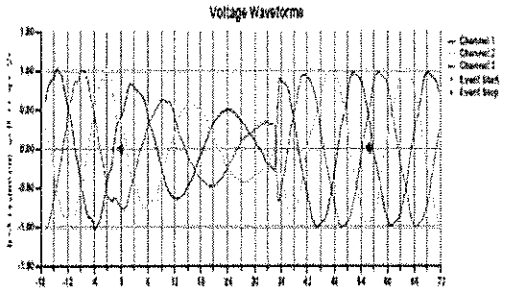
In smaller size drives these same components exist but are not separate modules.



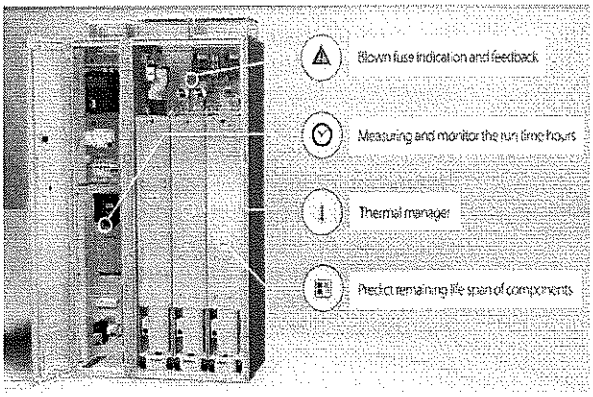
AFE Low Harmonic Drive Advantages:

Because the front end rectifier is "active" it can also provide some new features not available or even possible in VFDs before (note, some of these features are exclusive to Rockwell **PowerFlex 755TL** drives).





- *A **PowerFlex 755TL** AFE drive can monitor and adapt to any changes in the incoming line source. So if there is a voltage imbalance, the drive adapts to it without causing any other problems and maintains the harmonic mitigation.*
- *A **PowerFlex 755TL** AFE drive can create a "boost" to the DC bus when the line voltage sags. So rather than force the output to a lower level because of a utility or generator line sag event as other advanced VFDs can, the AFE drive can actually ride through a line sag of about 10% while still running the motor at full speed and torque!*
- *A **PowerFlex 755TL** AFE drive can continue operation in a sustained "brown out" of up to 70% line voltage by "folding back" the output but not tripping off-line.*
- *A **PowerFlex 755TL** AFE drive can correct Power Factor , both displacement and distortion, to 99.99% as seen by the line. But when the VFD is not being commanded to Run, a "sleep mode" function will open the pre-charge circuit and disconnect the L-C-L filter so that it doesn't leave the capacitors on-line all the time, potentially causing a leading power factor.*
- *The **PowerFlex 755TL** AFE drive offers a smaller footprint than side-by-side 18 pulse drives, but better thermal management than "stacked" designs. The main roll-out power modules of the larger (250HP and up) drives have their own individual thermal management systems, so each part cools only itself and no one single failure of a fan will cause issues with the entire drive. In addition, the PowerFlex 755TL series AFE drive has **prognostic capabilities** that will predict any impending failure of the cooling fans based on monitored operating values, allowing the user to replace them BEFORE they wear out.*
- *Prognostic capabilities in the **PowerFlex 755TL** AFE drive also extend to power systems, such as capacitors and transistors as well. Active modeling and performance monitoring are used to help predict potential impending issues before they become unscheduled shutdowns.*
- *On board diagnostics also alert operators of blown fuses, run time, thermal sues, motor maintenance scheduling and component lifespan issues.*



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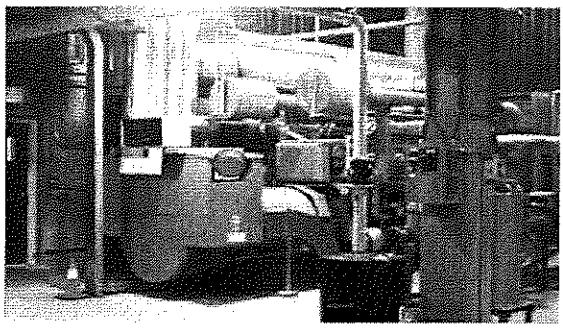
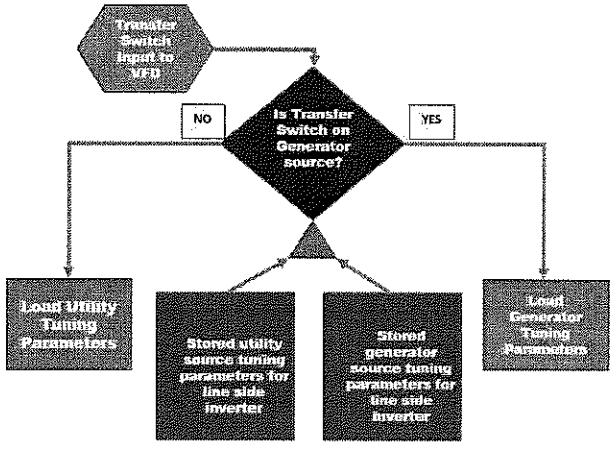
AFE Drive Challenges:

As with all technologies, there are challenges that must be considered and, if possible, overcome. Some of those challenges for AFE drives are:

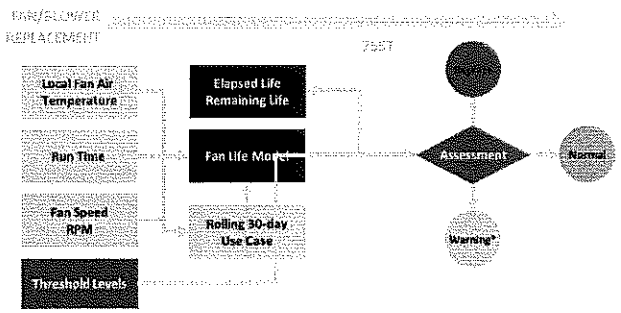
- ***High Order Harmonics:***
  Without proper filtering, high order harmonics can cause line disturbances, negative interactions and EMI/RFI problems. Not all AFE drive designs take that into account and may require special transformers.
  - *The **PowerFlex 755TL** drive however includes an L-C-L Filter assembly to handle harmonics up to the 50th order (3kHz). It works with any power distribution system.*
- ***Generator Operation:***
  Some AFE drives fed by high impedance sources ***such as back-up generators*** present a shutdown risk. A resonance created by the interaction of the high impedance source and the VFD leakage reactance can result in damage to the VFD. This phenomenon has been known for years but was not an issue until AFE drives were used for harmonics only (because when used for braking, you can't use generators anyway). One simplistic way to avoid the damage to the VFD is to disconnect it from the line when that resonance is detected. But for applications where a back-up generator is mandatory such as in the Water / Wastewater industry, this presents a problem because just when you need them the most, if the power goes out and the backup generator comes on, the VFDs are not available. So to address this, Rockwell has taken the following steps:



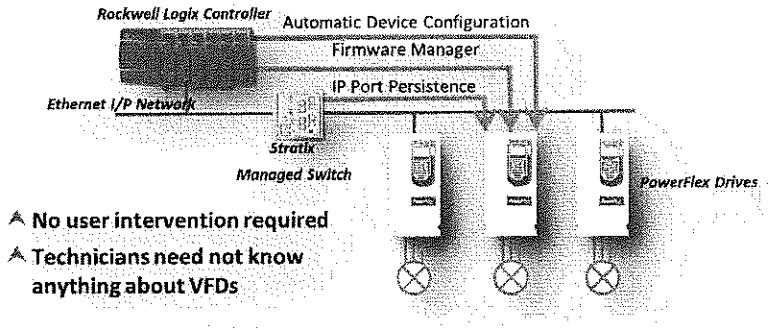
  - *The **PowerFlex 755TL** drive includes a patented system of additional passive dampening to address this problem. It has been specifically designed to avoid this potential resonance issue if at all possible; it will only open the line side input contactor as a last resort.*
  - *In all AFE drives, the line side inverter must be tuned to the incoming system impedance. Because this potential resonance issue is tied to the change in system impedance, the **PowerFlex 755T** can allow for storage of a second set of tuning values that can be loaded into the line side inverter programming when the line source changes. The **PowerFlex 755T** drives have an on-board PLC-like system, called **DeviceLogix**, that can execute programmed routines independently of the VFD operation. So by programming the drive to recognize an input from the transfer switch or a PLC, the drive can **automatically** switch to the second set of source tuning parameters. This allows for the drive to be specifically tuned to the backup generator impedance values to avoid having the resonance become a problem. To accommodate making this changeover after the utility source fails, a small control power UPS is used to keep the VFD control boards alive during the transfer so that by the time the generator starts and the ATS transfers, the VFD is ready for it.*



- ***Reliability concerns:***
  There is a perception that having two inverters increases the number of components in the system (compared to 18 pulse) and therefor has more things that can go wrong.
  - *The prognostic capabilities built-into the **PowerFlex 755TL** drive have been designed to INCREASE reliability and reduce down time by predicting and proactively alerting users to the most common impending issues such as component stress, thermal management issues and lifespan management of critical systems such as cooling fans, transistors and bus capacitors. In addition, the Inverter Modules have been designed to be identical, whether used for Line Side of Load Side, so they are completely interchangeable, reducing the required spare parts. These major systems are also designed to be easily replaceable by one person (using the Service Cart) in minutes.*



  - *Combined with the Rockwell exclusive "Automatic Device Configuration" feature with our controllers, technicians can get a drive up and running with a minimum of down time. ADC allows a Rockwell Controller (ControlLogix or CompactLogix) to store the programming of a Rockwell VFD so that if a VFD (or main control board) must be replaced, the technician need take no action in having to reprogram it, all they need to is connect line and load power and cycle power to it. The PLC, Managed Switch, Ethernet I/P network and VFD coordinate to automatically reconfigure the new component with no special knowledge of the VFD necessary from the technician. **This means that in emergency situations, any qualified electrician can replace a VFD whether they have training on them or not.***



*When compared to 18 pulse, the **PowerFlex 755TL** drive being capable of predicting and alerting users before something fails, having better thermal management aspects, their ability to survive and preform in a more varied electrical environment and the ease of servicing, replacing and returning them to service actually serves to make them **MORE reliable that 18 pulse drives**.*

Summary

When choosing a strategy for addressing harmonics in a facility, mitigating the contributions of large AC motor drives is an effective aspect of any approach. While the old standard for decades has been the "18 pulse drive" option, it was popular mainly because there was no effective alternative. More recently, new methods of applying Active Front End (AFE) drive technology solely for the purpose of mitigating harmonics, the so-called "Low Harmonic AFE drive", has gained momentum and not just because it is a less costly option. AFE drives also present a more reliable solution to harmonic mitigation while at the same time delivering new benefits not previously available in the older technologies. In particular, Rockwell PowerFlex 755TL AFE drives provide all of these benefits, plus solutions to the other challenges facing AFE Low Harmonic Drives that have been recently released, making the PowerFlex 755TL the right choice for your Low Harmonic Drive applications.

18 Pulse	PowerFlex 755-TL AFE
Magnetic solution	Electronic solution
Familiar	Newer concept
Comparable cost	Comparable cost
[illegible]	Voltage imbalance is irrelevant
[illegible]	Mitigation remains consistent with load
[illegible]	Same or smaller footprint
Long term heat issues (if smaller footprint is used)	No added heat issues, better thermal management
No added benefits	Several added benefits
Works with generators	Works with generators (Rockwell 755TL)

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LISTEN. THINK. SOLVE.

California American Water
Monterey Peninsula Water Supply Project
Design Build of Fitch Park ASR Wells 5 & 6 Above Ground Facilities

Attachment 10: **Allen Bradley's Comments**

Allen Bradley's Comments on VFD & Generator

VFD:

For the PowerFlex 755TL Low Harmonic Active Front End versions OR for the 18 pulse, we recommend that the *available* generator kVA capacity is no less than 150% of the VFD input kVA rating. By available we mean that if there are other loads services by the generator, they are factored in AFTER the 150% sizing requirement.

What Rockwell does to avoid problems with using a backup generator on the Active Front End versions is that our drive can be tuned to accept two different line source profiles, i.e. a Utility Source and a Backup Source. Internally within the drive, we allow selection of which source profile to use via a digital input or communication command. These profiles are programmed and done in the initial commissioning process. It does however require knowledge of the circuit impedance values. So, another requirement of the "portable" generator is that the same generator is used consistently so that the drive is connected to a known source profile, because the VFD itself can only store and select between two. If that is not possible, then the alternative is for the VFD to be connected to a PLC or other higher level control system with added memory and communications, in which ALL known source profiles are stored, then loaded by the PLC or control system into the VFD via comms when a specific generator is connected. If an Automatic Transfer Switch (ATS) is used for open transition of power from one source to the other, we recommend that the VFD have a DC UPS and an auxiliary control power input option card added to avoid a long re-boot sequence with the new source profile. If the backup source is only connected and transfer done manually, this is not necessary. One-line diagrams provided for this project do not indicate that an ATS is being used, so we are not including this option.

Generator:

Other than the above requirements, we do not require any special generator requirements for operating our drives. We recommend that generator suppliers be told of the minimum sizing mentioned above, and that 75% of the load will be non-linear (as mentioned in Item #13) so that they can select the proper offering in their product line.