APPENDIX F. DEMINERALIZED WATER SUPPLY OPTIONS

Introduction

Demineralized water supply is an issue for dual-fuel capability at CT-based generation plants because most current model heavy-frame CTs use dry low-NO_x burner systems to control NO_x emissions under current emission rules when firing natural gas, but must use water (or in some cases, steam) injection when firing a liquid fuel such as ULSD. The CT scope of supply for dual-fuel capability includes manifolds and burners, as well as forwarding pumps and filtering systems to accommodate water injection, but the balance-of-plant scope must provide for adequate supply and storage of demineralized water for CT injection purposes. CC plants require demineralized water for boiler make-up purposes on a continuous basis whenever the plant operates, but the flow rates for this use are an order of magnitude less than the rates required for NO_x control injection.

This appendix provides background for estimating the capital and operating costs associated with providing the demineralized water supply required for NO_x control for a typical F-technology plant with 2 CT units in either SC or CC configuration. The information on mobile demineralizer capacity is based primarily on communications with GE Water & Process Technologies.[1]

Water Requirements for NO_x Control Injection

Each GE 7FA CT requires approximately 350 gpm of demineralized water for injection when operating on ULSD, so the requirement for a 2x1 CC installation is approximately 700 gpm. The CC unit, with a net output of about 651 MW (winter conditions) also requires about 38 gpm for boiler makeup. The water quality specifications for boiler makeup are sometimes more stringent than those for CT water injection.

A 2-unit LMS100 SC installation would require about 135 gpm for water injection firing ULSD under winter conditions, but would require 127 gpm firing natural gas, since most such installations use water injection for both fuels. Hence, demineralized water does not constitute a major incremental cost of dual-fuel capability for LMS100 peaking stations.

Mobile Demineralizer Technology

Several companies maintain large fleets of mobile demineralizer trailers which can be transported to and put in service at a power plant site on an emergency basis or a longer term scheduled basis. GE maintains a 24/7 logistics center to dispatch trailers to where they are needed. Customers usually set up a contract that provides pricing and terms for emergency service.

[1] Discussions and communications with Mr. Scott Gorry of GE Water & Process Technologies, July 23, 2014 and July 31, 2014. Websites for suppliers of similar services, such as Evoqua Water Technologies (Siemens) and PureTec Industrial Water were reviewed, as well.

Each 43-foot trailer contains a string of demineralizer tanks, each with its own specialized anion, cation, or mixed bed media to achieve the required reduction in dissolved solids. Depending on the source water quality and final product specifications, a trailer might include a reverse osmosis unit as well. Trailers are equipped with propane heating systems to avoid freezing, and include filter units and standardized connection flanges for inlet and outlet hoses. The trailers are designed to be hooked up to a 120 volt, 20 amp power supply for lighting and controls.

Throughput rate for a typical application using good quality city water as raw water input is up to 800 gpm per trailer, so one trailer is typically sufficient to supply a 2-unit 7F.05 installation. The trailer is limited by raw water quality to a cumulative throughput of from 360,000 gallons at 235 ppm total dissolved solids (TDS) to 1,425,000 gallons at 225 ppm TDS. Once the cumulative throughput has been reached, the demineralizer units must be recharged and the accumulated solids disposed of. The service provider would set up another trailer and haul the spent trailer to its regeneration center.

Mobile Demineralizer Cost Structure

Mobile demineralizer service providers typically charge a flat fee per trailer that includes the cost of recharging and a set number of days of on-site availability. There is a daily demurrage charge for additional days on site and a round-trip transportation charge based on the distance from the provider's service center to the power plant site. Some generators rely on an inventory of stored demineralized water to cover one to three days of liquid fuel operation and arrange for emergency delivery of a trailer as soon as they begin to draw down that inventory. Other generators may arrange to have a trailer on site for the entire 3-month winter period. The optimum supply arrangement would depend on the expected frequency and duration of liquid fuel operation events, as well as the proximity of service provider regeneration centers.

GE provided some pricing parameters that it claims are typical of providers in a competitive market. The base charge per trailer was given as $6,000, which includes 10 days "free" of demurrage charges. After that, demurrage would be $600 per day. Freight was estimated at $55 per mile, charged in each direction with credit for consecutive exchanges.[2]

Plant-Provided Infrastructure

The generation plant would provide a pad for the trailer with connections from the raw water supply source and to the demineralized water storage tank. Both raw water and demineralized water systems would presumably be heat traced as necessary for expected winter design conditions. Hoses for the trailer connections should also be heat traced where appropriate. GE Water recommended a demineralized water storage capacity of 1,000,000 gallons, or about 24 hours of full load operating requirements for a 650 MW CC unit. The amount of raw water storage required would depend on the source of raw water. A dependable full-flow connection to city water might make raw water storage unnecessary.

[2] For a full season, the freight charge would be ($55/mile) x (distance in miles) x (No. of trailers used + 2).

Cost Examples

Based on information provided by GE Water, LAI developed a simplified model for estimating the cost of mobile demineralizer capacity for a 2x1 7FA CC unit and a 2x7FA SC station at a range of locations. It is assumed that the boiler make-up requirements for the combined cycle examples are provided with a separate system. The Newburgh, NY location has good quality raw water at 60 ppm TDS, and it is located 10 miles from a regeneration center. The Cleveland, OH location has poor quality raw water at 235 ppm TDS, and it is located 55 miles from a regeneration center. Petersburg, VA, is an intermediate location with moderate quality raw water (85 ppm TDS) and located about 14.5 miles from a regeneration center. It should be noted that other service providers would have regeneration centers at different distances from the locations. The examples developed in the table below show a range in average costs from $7.73 per 1,000 gallons to $26.27 per 1,000 gallons.

Mobile Demin Water Cases:						
Case	1	2	3	4	5	6
Assumptions:						
Plant Type	2x1 7FA CC	2x1 7FA CC	2x1 7FA CC	2x7FA SC	2x7FA SC	2x7FA SC
Nominal Capacity, MW	650	650	650	385	385	385
Demin water use (gpm)						
Firing gas	38	38	38	0	0	0
Incremental for injection firing oil	700	700	700	700	700	700
Plant Utilization on ULSD (hrs)						
Maximum annual hours on oil	720	720	720	720	720	720
Expected annual hours on oil (all in winter season)	240	240	240	120	120	120
Max consecutive hours on oil	72	72	72	24	24	24
Site Assumptions:						
General location						
State	NY	OH	VA	NY	OH	VA
City or County	Newburgh	Cleveland	Petersburg	Newburgh	Cleveland	Petersburg
Distance from Regeneration Center *(miles estimated by GE Water)*	10.0	55.0	14.5	10.0	55.0	14.5
Raw water source	City water	City water	City water	City water	City water	City water
TDS (ppm) *(estimated by GE Water)*	60	235	85	60	235	85
LAI Calculations:						
Cost at projected operating level						
Expected seasonal usage for water injection (gal)	10,080,000	10,080,000	10,080,000	5,040,000	5,040,000	5,040,000
Throughput per trailer, gal (85,500,000/TDS per GE data)	1,430,000	360,000	1,010,000	1,430,000	360,000	1,010,000
Trailers required per season	7.05	28.00	9.98	3.52	14.00	4.99
Days in winter peak season	121	121	121	121	121	121
Total free days, at 10 per trailer	70	280	100	40	140	50
Demurrage days = greater of 0 or (121 - free days)	51	0	21	81	0	71
Cost components:						
Base unit charges at $6,000	$42,300	$168,000	$59,900	$21,100	$84,000	$29,900
Freight charges at $55/mile x Distance x (No of Trailers + 2)	$5,000	$90,800	$9,600	$3,000	$48,400	$5,600
Demurrage at $600 per day	$30,600	$0	$12,600	$48,600	$0	$42,600
Total Cost per Winter	$77,900	$258,800	$82,100	$72,700	$132,400	$78,100
Effective cost per 1,000 gallons	$7.73	$25.67	$8.14	$14.42	$26.27	$15.50
Trailers per day at peak usage	0.70	2.80	1.00	0.70	2.80	1.00
Seasonal stand-by cost (no usage)	$73,700	$78,700	$74,200	$73,700	$78,700	$74,200