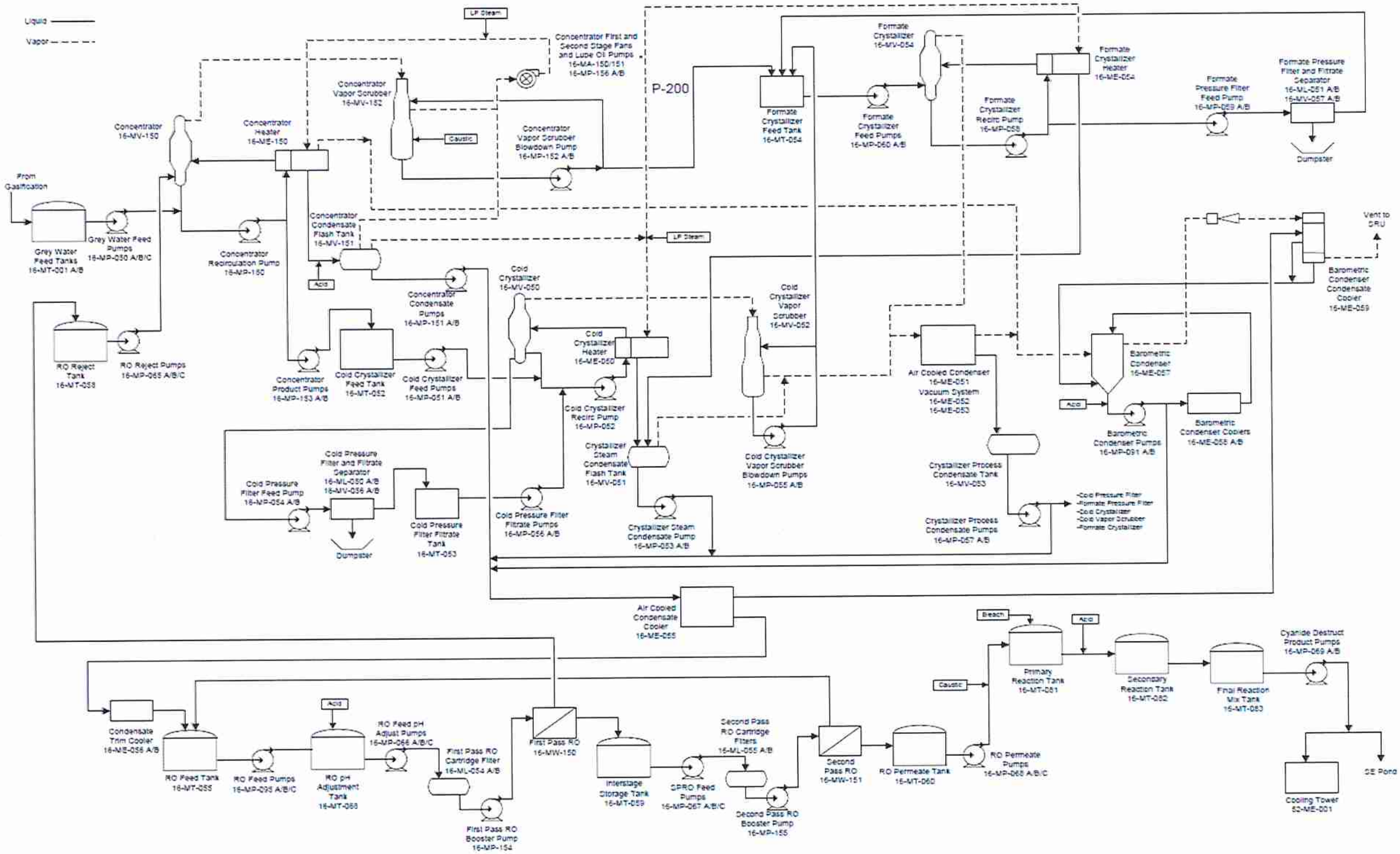
Attachment 1

Edwardsport Grey Water Treatment System Diagram

(Submitted as part of Appendix 2 to Duke Energy’s request for a variance)

Appendix C: Edwardsport IGCC Grey Water Process Flow Diagram



Attachment 2

EPA Request for Additional Information (November 18, 2016)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

NOV 18 2016

REPLY TO THE ATTENTION OF:

WN-16J

Mr. Patrick Coyle
Duke Energy – Environmental Services
139 E. Fourth Street, EM740
Cincinnati, OH 45202

Dear Mr. Coyle:

We are writing to you to request additional information relevant to your application for a fundamentally different factors variance that was submitted to the U.S. Environmental Protection Agency (EPA) on April 27, 2016. The referenced application requests a variance for the Edwardsport IGCC Station operated by Duke Energy Indiana, LLC from the effluent limitations guidelines and standards (ELGs) for the Steam Electric Power Generating Point Source Category that were published on November 3, 2015 (80 FR 67838). Your response to this request is voluntary. If you choose to respond, please provide the information in the specified format described below to EPA and the Indiana Department of Environmental Management by Monday December 12, 2016. If you decide not to provide the information requested here, EPA will make its decision based on your application dated April 28, 2016 and the record for the ELG rulemaking.

Specifically, EPA requests the following information from Duke Energy Indiana, LLC regarding the operations at the Edwardsport IGCC Station:

1) All analytical data for arsenic, mercury, selenium, TDS, and any other pollutants, for the time period of May 2013 through present (along with associated laboratory reports) for each of the wastestreams listed below. As such, your submittal should include, at minimum, the numerical data in an Excel spreadsheet, and the laboratory reports for all analytical data provided in Appendix 1 and Appendix 4 of the "Fundamentally Different Factors Variance Application for Duke Energy Indiana, LLC – Edwardsport IGCC Station," dated April 27, 2016.

    a. Grey water treatment system influent;
    b. Concentrator condensate;
    c. Crystallizer steam condensate;
    d. Crystallizer process condensate;
    e. Barometric condenser condensate;
    f. Condensate trim cooler (combined condensate); and
    g. Final greywater treatment effluent (Outfall 501).

2) Please provide the following flow rate information in an Excel spreadsheet:

   a. Maximum design flow rate for all wastestreams identified in request number 1.
   b. Average design flow rate for all wastestreams identified in request number 1.
   c. Average daily flow rate for the sample collection date(s) for all analytical data included in Appendix 1 and Appendix 4 of the "Fundamentally Different Factors Variance Application for Duke Energy Indiana, LLC – Edwardsport IGCC Station."
   d. Average daily flow rate for the sample collection date(s) for all analytical data provided in response to request number 1.

3) For all data, provide a detailed description of how the samples were collected and an annotated process flow diagram showing the sample collection location. Your submittal should include a description of the following sample identifiers included in your variance application:

   a. "Filtered;"
   b. "Influent;" and
   c. "Effluent."

4) EPA noticed in the data provided in Appendix 1 of the "Fundamentally Different Factors Variance Application for Duke Energy Indiana, LLC – Edwardsport IGCC Station," there was an order of magnitude increase in the effluent TDS concentration between the 10/8/2015 and the 10/13/2015 data. Additionally, both the influent arsenic and the influent mercury concentrations show an increase over the same time period. The data characteristics are indicative of atypical operations and may not represent normal operation of the gasification system and/or the wastewater treatment system. Absent information supporting that there were no indications of atypical operations from operational logs and monitoring equipment, EPA believes it may be appropriate to exclude these data as outliers. Should you believe these data do represent normal operation, please provide information supporting that conclusion.

We appreciate your efforts to provide the information described above by the requested date. If you have any questions as to why EPA is requesting this data or need clarification of any of the requests, please contact Mark Ackerman of my staff. Mr. Ackerman can be reached at (312) 353-4145 or at ackerman.mark@epa.gov.

Sincerely,

Kevin M. Pierard, Chief
NPDES Programs Branch

Cc: Paul Novak (IDEM), Electronically

Attachment 3

Supplemental Information Submitted by Duke Energy (December 9, 2016)

DUKE ENERGY.

139 E. Fourth Street, EM740
Cincinnati, Ohio 45202

December 9, 2016

VIA OVERNIGHT DELIVERY

Kevin M. Pierard, Chief
NPDES Programs Branch, WN-16J
Water Division
U.S. Environmental Protection Agency, Region 5
77 W. Jackson Boulevard
Chicago, IL 60604-3590

Re: Response to Request for Additional Information – Fundamentally Different Factors Variance Application for Duke Energy Indiana, LLC – Edwardsport IGCC Generating Station (NPDES Permit IN0002780)

Dear Mr. Pierard:

The following information is provided in response to your letter dated November 18, 2016, requesting additional information from Duke Energy Indiana, LLC (Duke Energy) relating to its pending application for a fundamentally different factors variance from the recently adopted effluent limitations guidelines (ELGs) for the Steam Electric Power Generating Point Source Category. The four specific requests for information identified in your letter are reiterated below, followed by Duke Energy's responses.

Request No. 1

All analytical data for arsenic, mercury, selenium, TDS, and any other pollutants, for the time period of May 2013 through the present (along with associated laboratory reports) for each of the wastestreams listed below. . . .

a. Grey water treatment system influent;
b. Concentrator condensate;
c. Crystallizer steam condensate;
d. Crystallizer process condensate;
e. Barometric condenser condensate;
f. Condensate trim cooler (combined condensate); and
g. Final greywater treatment effluent (Outfall 501).

Response

Attached, please find a spreadsheet summarizing the available analytical data for the grey water treatment system for the time period of May 2013 to present. The contract lab reports supporting this data, consisting of multiple PDF-format files, have been copied to an enclosed flash drive. Individual PDF files on the flash drive have been named to match the applicable sample date as shown on the spreadsheet (e.g., "2015-09-08 Mercury.pdf"). At this time, we have been unable to locate the lab reports for two early sampling dates (5/9/2013 and 8/25/2013), from the period of IGCC startup. We are continuing to search for these reports and will provide them if located.

While gathering the requested information, we have belatedly become aware that Edwardsport operating personnel collect additional analytical data (e.g., pH and solids) from within the grey water treatment system for process control purposes. Some of this data may correspond to wastewater sampling locations identified by EPA above as within the scope of Request No. 1. At this time, it is unclear but doubtful that this data has been obtained through EPA-approved methods or has been subject to NPDES-appropriate quality control procedures. Consequently, though technically within the scope of requested information, Duke Energy doubts its utility for EPA in its review of the FDF variance application. In order to meet EPA's voluntary submission deadline of 12/12/2016, this process control data has not been assembled or included with this submission.

Request No. 2

Please provide the following flow rate information in an Excel spreadsheet:

a. Maximum design flow rate for all wastestreams identified in request number 1.
b. Average design flow rate for all wastestreams identified in request number 1.
c. Average daily flow rate for the sample collection date(s) for all analytical data included in Appendix 1 and Appendix 4 of the "Fundamentally Different Factors Variance Application for Duke Energy Indiana, LLC – Edwardsport IGCC Station,"
d. Average daily flow rate for the sample collection date(s) for all analytical data provided in response to request number 1.

Response

Attached, please find a spreadsheet summarizing available flow data for the grey water treatment process, including maximum and average design flow rates, and the average daily flow rates corresponding to sample collection dates. Please note that these daily flow values have been derived from in-process meters intended to provide system operators with reasonably accurate information for the purpose of maintaining process water flows and balances within acceptable ranges. Though the process flow meters are periodically calibrated, individual daily values may include inaccuracies.

Request No. 3

For all data, provide a detailed description of how samples were collected and an annotated process flow diagram showing the sample collection location. Your submittal should include a description of the following sample identifiers included in your variance application:

a. "Filtered;"
b. "Influent;" and
c. "Effluent."

Response

Attached, please find an annotated process flow diagram showing grey water sample collection locations. As used in Duke Energy's FDF variance application, these terms have the following meanings:

a. "Filtered" means the Station service water, which is obtained from groundwater collector wells, then clarified and filtered, and transferred to the Service Water Tank prior to distribution for general Station use. The "filtered water" samples were collected at the Service Water Tank, far upstream of the grey water treatment system, for the purpose of determining source water concentrations of mercury, arsenic, selenium, and TDS.

b. "Influent" means the influent to the grey water treatment system, as measured at the grey water feed pumps.

c. "Effluent" means the effluent from the grey water treatment system, as measured at the final transfer pumps, which send the treated greywater either to the gasification cooling towers or to the Southeast Pond.

Wastewater samples reported in the FDF variance application were collected by grab sampling and were handled and analyzed in accordance with methods approved by EPA (i.e., published at 40 CFR part 136) for the specific parameter. In particular, mercury samples were collected using Method 1669 and analyzed using Method 1631E.

Request No. 4

EPA noticed in the data provided in Appendix 1 of the "Fundamentally Different Factors Variance Application for Duke Energy Indiana, LLC – Edwardsport IGCC Station," there was an order of magnitude increase in the effluent TDS concentration between the 10/8/2015 and the 10/13/2015 data. Additionally, both the influent arsenic and the influent mercury concentrations show an increase over the same time period. The data characteristics are indicative of atypical operations and may not represent normal operation of the gasification system and/or the wastewater treatment system. Absent information supporting that there were no indications of atypical operations from operational logs and monitoring equipment, EPA believes it may be appropriate to exclude these data as outliers. Should you believe these data do represent normal operation, please provide information supporting that conclusion.

Response

EPA has expressed concern, on the basis of an order of magnitude increase in the effluent concentration of TDS between the dates of 10/8/2015 and 10/13/2015 and lesser increases in influent arsenic and mercury concentrations between the same dates, that the data on 10/13/2015 are indicative of atypical operations of the gasification system and/or the wastewater treatment system at the Edwardsport IGCC Station. Consequently, EPA suggests that it may be appropriate to exclude the 10/13/2015 data as outliers unrepresentative of normal operation, absent information to the contrary.

Duke Energy respectfully disagrees with the tentative conclusions drawn by EPA from the referenced 10/13/2015 data for reasons that follow. Primarily, the disagreement with EPA is based on Duke Energy's perception and understanding that the variations in pollutant concentrations between these two successive sampling dates are rather routine for both effluent or influent of the grey water treatment system. Other than the increase in TDS effluent concentration between those dates, all other pollutant concentration variations, influent and effluent, are in the range of one standard deviation and do not warrant an inference of atypical or abnormal process or treatment operations. Even the increase in TDS effluent concentration is within the scope of a lognormal distribution.

Variability of Effluent and Influent Data for the Grey Water Treatment System. It is recognized that the effluent value of TDS on 10/13/2015 is substantially higher than other effluent values of TDS in the data set, exceeding them by factors ranging from 3.7 to more than 10. That said, it also can be observed that the effluent TDS concentration measured on 10/13/2015 appears to be near the periphery of a lognormal distribution. The concentration of 222 mg/l is slightly more than the sum of the mean and three standard deviations – 209.9 mg/l. However, even if it were appropriate to consider this singular value of TDS effluent as a potential outlier, such a characterization definitely would not be appropriate for the variations of the same period in effluent concentrations of mercury or arsenic. Furthermore, none of the influent concentrations for arsenic, mercury or TDS displays unusual variation.

The effluent concentration of mercury actually dropped from 5.79 ng/l to 3.05 ng/l between 10/8/2015 and 10/13/2015. The differential is less than the standard deviation for effluent data (3.72 ng/l for the date range of 9/8/2015 to 10/15/2015). The effluent concentration of arsenic on 10/13/2015 shows no measurable change from the effluent on 10/8/2015: both are < 1.0 ug/l.

Similar moderate variations occurred in the influent concentrations of all three pollutants between 10/8/2015 and 10/13/2015. For mercury, the influent concentration increased from 11.8 ng/l to 30.4 ng/l, a differential of 18.6 ng/l, which is only slightly greater than one standard deviation for this data set, which is 15.1 ng/l. Moreover, on three other occasions within this data set, larger variations occurred between the results from adjacent sampling dates. For arsenic, the influent concentration increased from 38 ug/l to 210 ug/l between samples from 10/8/2015 and 10/13/2015, for a differential of 172 ug/l, which is less than the standard deviation of this data set of 284.2 ug/l. TDS influent increased between these two dates from 1,660 mg/l to 2,230 mg/l, a differential of 570 mg/l. This TDS influent concentration differential is about 1.5 times the standard deviation for this data set of 386.4 mg/l. In addition, it may be noted that the TDS concentration of 1,660 mg/l on 10/8/2015 is considerably below the mean concentration of 2,410 mg/l for this data set and the value of 2,230 mg/l on 10/13/2015 is still below the mean value.

So, based on an examination of the 10/8/2015 data and the 10/13/2015 data within the context of the entire data set from 9/8/2015 through 10/15/2015, Duke Energy believes that there is no basis for excluding any data from consideration in setting alternative ELG values for gasification wastewater. This conclusion is independent of the presence or lack of information concerning the operational normalcy of Edwardsport IGCC Station on 10/13/2015.

Contemporaneous Operational Information. For reasons explained above, Duke Energy believes that the variability between successive samples of influent or effluent for the grey water treatment system on 10/8/2015 and 10/13/2015 is rather routine and does not warrant an inference of atypical or abnormal process or treatment operations. Nonetheless, Duke Energy is not aware of information that would support a conclusion that the gasification process or the grey water treatment system was not operating in a normal manner on 10/13/2015.

As a final point, it should be noted that the Edwardsport IGCC grey water treatment process discharge (NPDES outfall 501) has been monitored only intermittently since the beginning of plant operations in mid-2013. The former version of the NPDES permit, effective 12/1/2010, required monitoring the internal outfall twice monthly upon IGCC start-up for a six-month period. The current version of the permit restored this regular monitoring, effective 4/1/2016. In all, there have been 14 months of required sampling of the grey water treatment system effluent, resulting in approximately 28 sampling events, since the commencement of operations. In contrast, there is a 29-month period between these intervals of regular monitoring in which no monitoring of the grey water treatment system effluent was required. Thus, required sampling periods represent only one-third of the operational history of the gasification and grey water treatment processes. Given the relative sparseness of the monitoring data and the fact that the gasification and grey water treatment processes are complex and operational experience with those processes is still limited, it is possible – and perhaps likely – that not all operating conditions for the IGCC plant within the range of normal variability are represented by the monitoring data. Consequently, absent certain knowledge to the contrary, Duke Energy believes it would be inappropriate to disregard any otherwise valid data as atypical – unrepresentative of the range of normal operations – on the basis of an unexpected result, or simply because that data is positioned on the upper bound of the available data set.

In conclusion, Duke Energy respectfully reiterates its request for approval of its FDF variance application. If you have further questions or would like to discuss the enclosed information, please contact me at 513-287-2268 or pat.coyle@duke-energy.com.

Sincerely,

Patrick Coyle

Patrick Coyle
Duke Energy – Environmental Services

Enclosures

cc: Paul Novak, IDEM OWQ, Permits Branch

Edwardsport Grey Water Treatment Analyses, 2013-2016

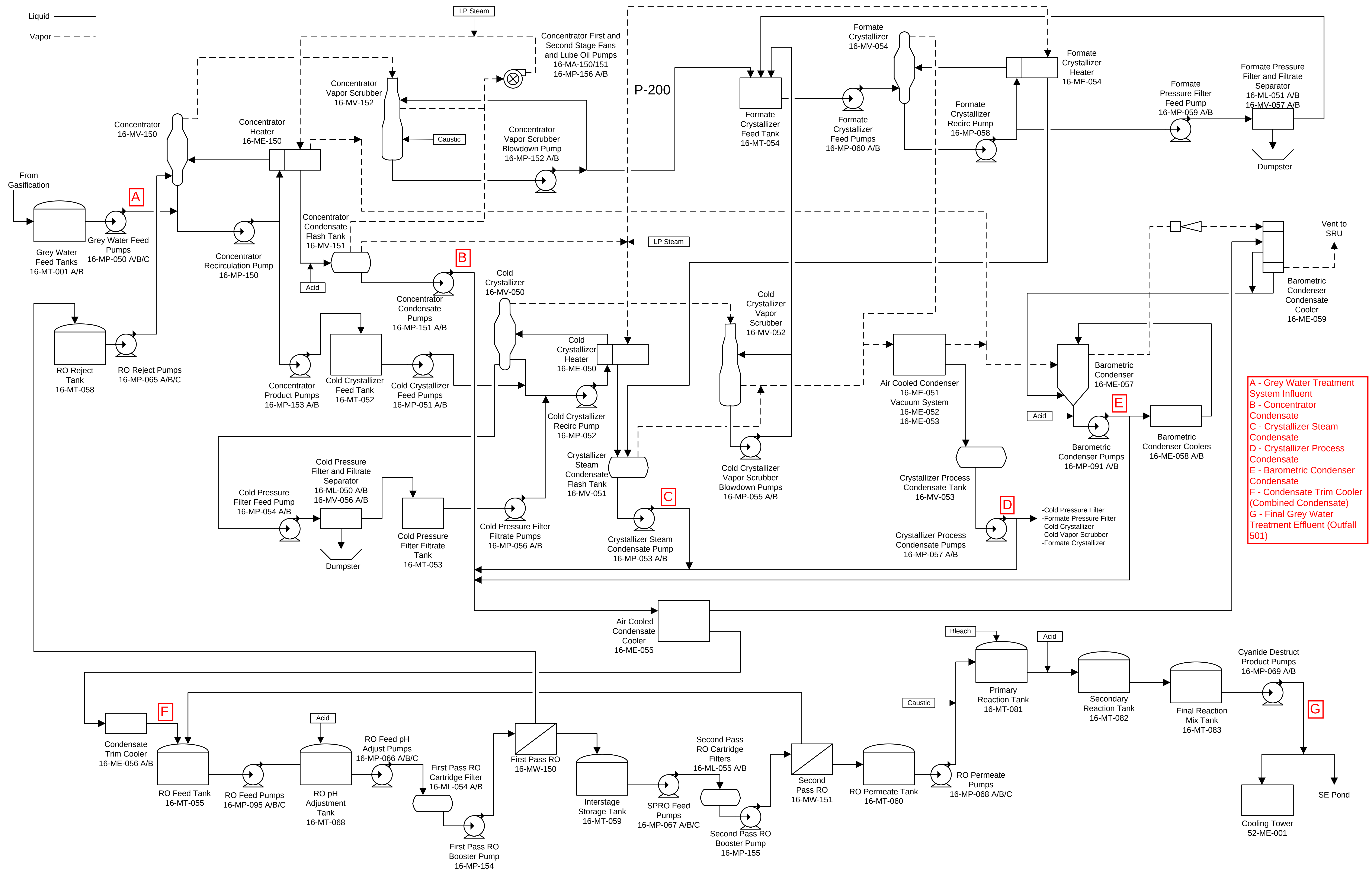
Note: Metals results represent the total recoverable metal unless otherwise indicated.

	Mercury (ng/l)							Arsenic (ug/l)			Selenium (ug/l)			TDS (mg/l)				Aluminum (mg/l)	Antimony (mg/l)	Barium (mg/l)	Beryllium (mg/l)
Sample date:	**Filtered water**	**Influent**	**Concentrator Condensate**	**Crystallizer Steam Condensate**	**Barometric Condenser Condensate**	**Condensate Trim Cooler**	**Effluent**	**Filtered water**	**Influent**	**Effluent**	**Filtered water**	**Influent**	**Effluent**	**Filtered water**	**Grey Water Feed Tank (Influent)**	**Condensate Trim Cooler Discharge**	**Effluent**	**Effluent**	**Effluent**	**Effluent**	**Effluent**
5/9/2013										< 0.06			7					0.003	< 0.00003	< 0.00003	< 0.00001
5/23/2013										< 0.06			< 0.2					0.008	< 0.00003	< 0.00003	< 0.00001
6/6/2013										< 6			< 0.2					0.011	< 0.00003	< 0.00003	< 0.00001
6/13/2013										< 6			< 0.2					0.006	< 0.00003	< 0.00003	< 0.00001
7/22/2013							2.08														
7/24/2013										2			4					0.009	< 0.00003	0.00200	< 0.00001
7/31/2013										< 0.6			< 0.2					0.061	0.01700	0.00300	< 0.00001
8/2/2013										< 0.6			< 0.2					0.295	0.00600	0.00300	< 0.00001
8/8/2013							9.58														
8/21/2013										15			< 10.0					0.020	< 0.01000	< 0.01000	< 0.01000
8/25/2013										15			< 0.2					0.020	< 0.00003	< 0.00003	< 0.00001
9/5/2013										< 0.06			< 0.2					0.016	< 0.00003	< 0.00003	< 0.00001
9/25/2013										< 0.06			< 0.2					0.040	< 0.00003	< 0.00003	< 0.00001
10/3/2013							2.53														
10/8/2013										< 0.6			< 0.2					0.028	< 0.00003	< 0.00003	< 0.00001
10/17/2013										< 0.6			< 0.2					0.057	< 0.00003	< 0.00003	< 0.00001
9/8/2015	0.540	6.55					12.8	< 1.0	1,100	< 1.0	< 1.0	260	< 1.0	300	2,540		20				
9/10/2015	< 0.50	15.8					5.25	< 1.0	120	< 1.0	< 1.0	160	< 1.0	300	3,020		40				
9/15/2015	< 0.50	10.8					10.3	< 2.0	120	< 2.0	< 2.0	320	< 2.0	120	2,560		< 10				
9/17/2015	< 0.50	21.2					6.55	< 2.0	130	< 2.0	< 2.0	130	< 2.0	280	2,090		20				
9/22/2015	< 0.50	22.0					10.8	< 1.0	31	< 1.0	< 1.0	78	< 1.0	324	2,200		10				
9/24/2015	< 0.50	23.4					11.5	< 1.0	63	< 1.0	< 1.0	87	< 1.0	322	2,140		< 10				
9/29/2015	< 0.50	44.4					6.40	< 1.0	67	< 1.0	< 1.0	66	< 1.0	420	2,700		32				
10/1/2015	< 0.50	7.35					3.92	< 1.0	42	< 1.0	< 1.0	80	< 1.0	336	2,980		20				
10/6/2015	< 0.50	15.6					2.40	< 1.0	33	< 1.0	< 1.0	140	< 1.0	340	2,680		20				
10/8/2015	< 0.50	11.8					5.79	< 1.0	38	< 1.0	< 1.0	160	10.0	380	1,660		14				
10/13/2015	< 0.50	30.4					3.05	< 1.0	210	< 1.0	< 1.0	140	< 1.0	320	2,230		222				
10/13/2015		0.694 (dissolved)					3.61 (dissolved)														
10/15/2015	< 0.50	59.5					0.877	< 1.0	230	< 1.0	< 1.0	110	< 1.0	340	2,120		60				
10/15/2015		0.694 (dissolved)					0.938 (dissolved)														
4/5/2016			7.03	< 0.50	3.31	15.60	4.74			< 1.0			2.9				34				
4/6/2016			7.25	< 0.50	1.34	16.30	8.39			< 1.0			4.1				72				
4/8/2016			1.72	0.59	1.15	8.88	3.09			< 1.0			3.8				42				
4/14/2016															586	1,760					
5/27/2016							17.8			< 1.0			14.2				< 10				
5/31/2016							4.46			< 1.0			< 1.0				< 10				
6/7/2016	< 0.50						1.51			< 1.0			< 1.0				24				
6/15/2016							< 0.50			< 1.0			< 1.0				< 10				
7/6/2016							3.53			< 1.0			1.1				< 10				
7/13/2016							1.44			< 1.0			1.3				< 10				
8/3/2016							< 0.50			< 1.0			< 1.0				< 10				
8/10/2016							4.07			< 1.0			7.2				< 10				
9/7/2016							2.05			< 1.0			1.5				< 10				
9/14/2016							0.78			< 1.0			< 1.0				< 10				
10/1/2016							1.79			< 1.0			1.0				30				
Maximum	**0.54**	**59.5**	**7.25**	**0.59**	**3.31**	**16.3**	**17.8**	**2.0**	**1,100**	**15**	**2**	**320**	**14.2**	**420**	**3,020**		**222**	**0.295**	**0.017**	**0.010**	**0.010**
Average	**< 0.5**	**22.4**	**5.3**	**< 0.5**	**1.9**	**13.6**	**5.1**	**1.2**	**182**	**1.9**	**1.2**	**144**	**2.3**	**315**	**2,270**		**29.6**	**0.0**	**0.0026**	**0.0014**	**0.0008**
Minimum	**< 0.5**	**6.6**	**1.7**	**< 0.5**	**1.2**	**8.9**	**< 0.5**	**< 1.0**	**31**	**< 0.1**	**< 1.0**	**66**	**< 0.2**	**120**	**586**		**< 10**	**0.0**	**< 0.00**	**< 0.0**	**< 0.00**
No. of results	**13**	**12**	**3**	**3**	**3**	**3**	**29**	**12**	**12**	**39**	**12**	**12**	**39**	**12**	**13**		**26**	**13**	**13**	**13**	**13**

	Cadmium (mg/l)	Chloride (mg/l)	Chromium (mg/l)	Copper (mg/l)	Cyanide (mg/l)		Fluoride F (mg/l)	Iron (mg/l)	Lead (mg/l)	Manganese (mg/l)	NH3 as N (mg/l)	Nickel (mg/l)	Oil & Grease (mg/l)	pH (SU)	Phenol (mg/l)	Silver (mg/l)	TSS (mg/l)	Sulfate (mg/l)	Sulfide (as S) (mg/l)	Thallium (mg/l)	Zinc (mg/l)
Sample date:	Effluent	Effluent	Effluent	Effluent	Total as CN, Effluent	Free, Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
5/9/2013	< 0.00002	< 0.400	< 0.0004	< 0.00004	0.209	0.108	1.360	0.001	< 0.00002	< 0.00002	1.15	< 0.0002	< 0.90	7.30	< 0.001	< 0.00001	< 1.00	< 0.800	0.025	< 0.0003	0.010
5/23/2013	< 0.00002	< 0.400	< 0.0004	< 0.00004	0.505	0.340	0.880	0.004	< 0.00002	< 0.00002	1.14	< 0.0002	< 0.90	8.30	0.012	< 0.00001	< 1.00	0.800	0.095	< 0.0003	0.019
6/6/2013	< 0.00002	< 0.400	< 0.0004	0.003	0.845	0.798	0.071	0.007	< 0.00002	0.00500	0.76	0.0020	< 0.90	8.00	0.009	< 0.00001	< 1.00	0.400	13.400	< 0.0003	0.008
6/13/2013	< 0.00002	< 0.400	< 0.0004	0.003	0.210	< 0.001	0.599	0.011	< 0.00002	< 0.00002	1.14	0.0020	< 0.90	8.00	0.008	< 0.00001	< 1.00	< 0.100	0.163	< 0.0003	0.011
7/22/2013																					
7/24/2013	< 0.00002	0.120	< 0.0004	< 0.00004	3.750	3.060	0.240	0.016	0.00400	< 0.00002	1.27	0.0010	< 0.90	7.90	< 0.001	< 0.00001	< 1.00	0.600	6.300	0.0100	0.014
7/31/2013	< 0.00002	< 0.040	0.0010	< 0.00004	0.280	0.260	0.260	0.058	< 0.00002	0.00100	1.49	< 0.0002	< 0.90	8.40	0.084	< 0.00001	< 1.00	0.400	0.352	< 0.0003	0.018
8/2/2013	< 0.00002	< 0.040	< 0.0004	0.00100	0.250	0.243	0.270	0.012	< 0.00002	< 0.00002	1.10	< 0.0002	< 0.90	8.10	0.072	< 0.00001	< 1.00	1.000	0.654	< 0.0003	0.025
8/8/2013																					
8/21/2013	< 0.01000	< 0.070	< 0.0100	< 0.01000	0.880	0.868	0.050	0.043	0.03000	< 0.01000	1.05	< 0.0100	< 5.00		< 0.005	< 0.01000	< 4.00	0.456	1.580	0.0320	0.025
8/25/2013	< 0.00002	< 0.040	< 0.0004	< 0.00004	0.880	0.868	0.050	0.043	0.03000	< 0.00002	1.05	< 0.0002	< 0.90	7.50	< 0.001	< 0.00001	< 1.00	0.500	1.580	0.0320	0.025
9/5/2013	< 0.00002	< 0.040	< 0.0004	< 0.00004	0.250	0.229		0.054	< 0.00002	< 0.00002	0.85	< 0.0002	< 0.90	8.70	0.020	< 0.00001	< 1.00		3.450	< 0.0003	0.034
9/25/2013	< 0.00002	< 0.070	< 0.0004	< 0.00004	0.095	0.087	0.142	0.036	< 0.00002	< 0.00002	< 0.20	< 0.0002	< 0.90	9.50	0.009	< 0.00001	< 1.00	0.872	< 0.002	< 0.0003	0.038
10/3/2013																					
10/8/2013	< 0.00002	< 0.040	< 0.0004	< 0.00004	0.030	0.029	0.096	0.036	< 0.00002	< 0.00002	0.56	< 0.0002	< 0.90	6.70	0.012	< 0.00001	< 1.00	0.625	0.013	< 0.0003	0.039
10/17/2013	< 0.00002	< 0.040	< 0.0004	< 0.00004	0.200	0.191	0.071	0.013	< 0.00002	< 0.00002	1.52	< 0.0002	< 0.90	7.30	< 0.001	< 0.00001	< 1.00	< 0.078	0.803	< 0.0003	0.019
9/8/2015																					
9/10/2015																					
9/15/2015																					
9/17/2015																					
9/22/2015																					
9/24/2015																					
9/29/2015																					
10/1/2015																					
10/6/2015																					
10/8/2015																					
10/13/2015																					
10/13/2015																					
10/15/2015																					
10/15/2015																					
4/5/2016																					
4/6/2016																					
4/8/2016																					
4/14/2016																					
5/27/2016																					
5/31/2016																					
6/7/2016																					
6/15/2016																					
7/6/2016																					
7/13/2016																					
8/3/2016																					
8/10/2016																					
9/7/2016																					
9/14/2016																					
10/1/2016																					
Maximum	**0.01**	**0.4**	**0.01**	**0.01**	**3.75**	**3.06**	**1.36**	**0.058**	**0.03**	**0.01**	**1.52**	**0.01**	**5**	**9.5**	**0.084**	**0.01**	**4**	**1**	**13.4**	**0.032**	**0.039**
Average	**0.0**	**0.2**	**0.0**	**0.0**	**0.6**	**0.5**	**0.3**	**0.026**	**0.005**	**0.0**	**1.0**	**0.0**	**1.2**	**8.0**	**0.0**	**0.0**	**1.2**	**0.6**	**2.2**	**0.0**	**0.022**
Minimum	**< 0.0**	**< 0.0**	**< 0.0**	**< 0.0**	**0.030**	**< 0.001**	**0.1**	**0.001**	**< 0.00002**	**< 0.0**	**< 0.2**	**< 0.0002**	**< 0.9**	**6.7**	**< 0.0**	**< 0.0**	**< 1.0**	**< 0.1**	**< 0.002**	**< 0.0003**	**0.008**
No. of results	**13**	**13**	**13**	**13**	**13**	**13**	**12**	**13**	**13**	**13**	**13**	**13**	**13**	**12**	**13**	**13**	**13**	**12**	**13**	**13**	**13**

Grey Water Treatment System Flow Rates	Grey Water Treatment System Influent (gpm)	Concentrator Condensate (gpm)	Crystallizer Steam Condensate (gpm)	Crystallizer Process Condensate (gpm)	Barometric Condenser Condensate (gpm)	Condensate Trim Cooler (gpm)	Greywater Treatment System Effluent (gpm)
Maximum design flow rate:	(Not available)	20	(Not available)	42	9	857	746.5
Average design flow rate, 50%, 175 Deg:	(Not available)	20	(Not available)	25	6	516	(Not available)
Average daily rate, sample date: 5/9/2013	237	0	(Not measured)	0	700	192	56*
5/23/2013	256	0	-	0	700	331	250*
6/6/2013	451	0	-	0	900	369	354*
6/13/2013	336	0	-	448	750	25	229*
7/22/2013	240	0	-	1	700	260	245
7/24/2013	236	0	-	460	700	177	347*
7/31/2013	245	0	-	464	689	329	354*
8/2/2013	239	0	-	468	753	332	299*
8/8/2013	261	0	-	447	495	168	154
8/21/2013	270	0	-	440	698	389	369
8/25/2013	259	0	-	425	682	365	333*
9/5/2013	504	0	-	421	813	344	472*
9/25/2013	263	0	-	216	741	373	326*
10/3/2013	212	0	-	204	717	18	11
10/8/2013	262	0	-	201	554	382	299*
10/17/2013	356	0	-	381	581	510	493*
9/8/2015	413	0	-	366	608	436	458
9/10/2015	424	0	-	363	595	433	452
9/15/2015	415	0	-	366	589	431	427
9/17/2015	413	0	-	365	688	428	448
9/22/2015	416	0	-	364	797	434	430
9/24/2015	426	0	-	361	759	462	469
9/29/2015	412	0	-	336	811	438	433
10/1/2015	417	0	-	330	853	428	420
10/6/2015	413	0	-	336	889	439	425
10/8/2015	413	0	-	345	888	443	435
10/13/2015	383	0	-	106	905	409	411
10/15/2015	189	0	-	377	894	416	417
4/5/2016	228	0	-	332	877	407	390
4/6/2016	252	0	-	331	869	431	347*
4/8/2016	249	0	-	334	828	450	444
4/14/2016	262	0	-	328	692	424	412
5/27/2016	390	0	-	0	414	435	222*
5/31/2016	264	0	-	353	488	295	250*
6/7/2016	381	58	-	340	626	423	444*
6/15/2016	268	58	-	371	561	310	313*
7/6/2016	402	58	-	42	723	445	451*
7/13/2016	368	58	-	325	633	402	382*
8/3/2016	305	58	-	330	687	342	229*
8/10/2016	428	58	-	322	611	464	472*
9/7/2016	419	58	-	330	534	498	569*
9/14/2016	410	58	-	341	527	474	451*
10/1/2016	285	58	-	152	165	294	181*

Note: System effluent flow values in gpm marked with an asterisk (*) have been back-calculated from NPDES-reported MGD values.



Liquid
Vapor
LP Steam
Concentrator First and Second Stage Fans and Lube Oil Pumps 16-MA-150/151 16-MP-156 A/B
P-200
Formate Crystallizer 16-MV-054
Formate Crystallizer Heater 16-ME-054
Formate Pressure Filter and Filtrate Separator 16-ML-051 A/B 16-MV-057 A/B
Concentrator Vapor Scrubber 16-MV-152
Concentrator 16-MV-150
Concentrator Heater 16-ME-150
Caustic
Concentrator Vapor Scrubber Blowdown Pump 16-MP-152 A/B
Formate Crystallizer Feed Tank 16-MT-054
Formate Crystallizer Feed Pumps 16-MP-060 A/B
Formate Crystallizer Recirc Pump 16-MP-058
Formate Pressure Filter Feed Pump 16-MP-059 A/B
Dumpster
From Gasification
A
Grey Water Feed Tanks 16-MT-001 A/B
Grey Water Feed Pumps 16-MP-050 A/B/C
Concentrator Recirculation Pump 16-MP-150
Concentrator Condensate Flash Tank 16-MV-151
LP Steam
Acid
B
Concentrator Condensate Pumps 16-MP-151 A/B
Vent to SRU
Barometric Condenser Condensate Cooler 16-ME-059
RO Reject Tank 16-MT-058
RO Reject Pumps 16-MP-065 A/B/C
Concentrator Product Pumps 16-MP-153 A/B
Cold Crystallizer Feed Tank 16-MT-052
Cold Crystallizer Feed Pumps 16-MP-051 A/B
Cold Crystallizer 16-MV-050
Cold Crystallizer Heater 16-ME-050
Cold Crystallizer Recirc Pump 16-MP-052
Cold Crystallizer Vapor Scrubber 16-MV-052
Cold Crystallizer Vapor Scrubber Blowdown Pumps 16-MP-055 A/B
Air Cooled Condenser 16-ME-051 Vacuum System 16-ME-052 16-ME-053
Barometric Condenser 16-ME-057
Acid
E
Barometric Condenser Pumps 16-MP-091 A/B
Barometric Condenser Coolers 16-ME-058 A/B
A - Grey Water Treatment System Influent
B - Concentrator Condensate
C - Crystallizer Steam Condensate
D - Crystallizer Process Condensate
E - Barometric Condenser Condensate
F - Condensate Trim Cooler (Combined Condensate)
G - Final Grey Water Treatment Effluent (Outfall 501)
Cold Pressure Filter and Filtrate Separator 16-ML-050 A/B 16-MV-056 A/B
Cold Pressure Filter Feed Pump 16-MP-054 A/B
Dumpster
Cold Pressure Filter Filtrate Tank 16-MT-053
Cold Pressure Filter Filtrate Pumps 16-MP-056 A/B
Crystallizer Steam Condensate Flash Tank 16-MV-051
C
Crystallizer Steam Condensate Pump 16-MP-053 A/B
Crystallizer Process Condensate Tank 16-MV-053
D
Crystallizer Process Condensate Pumps 16-MP-057 A/B
-Cold Pressure Filter
-Formate Pressure Filter
-Cold Crystallizer
-Cold Vapor Scrubber
-Formate Crystallizer
Air Cooled Condensate Cooler 16-ME-055
Bleach
Acid
Caustic
Primary Reaction Tank 16-MT-081
Secondary Reaction Tank 16-MT-082
Final Reaction Mix Tank 16-MT-083
Cyanide Destruct Product Pumps 16-MP-069 A/B
G
Condensate Trim Cooler 16-ME-056 A/B
F
RO Feed Tank 16-MT-055
RO Feed Pumps 16-MP-095 A/B/C
Acid
RO pH Adjustment Tank 16-MT-068
RO Feed pH Adjust Pumps 16-MP-066 A/B/C
First Pass RO Cartridge Filter 16-ML-054 A/B
First Pass RO Booster Pump 16-MP-154
First Pass RO 16-MW-150
Interstage Storage Tank 16-MT-059
SPRO Feed Pumps 16-MP-067 A/B/C
Second Pass RO Cartridge Filters 16-ML-055 A/B
Second Pass RO Booster Pump 16-MP-155
Second Pass RO 16-MW-151
RO Permeate Tank 16-MT-060
RO Permeate Pumps 16-MP-068 A/B/C
Cooling Tower 52-ME-001
SE Pond

Attachment 4

EPA Request for Additional Information (January 5, 2017)

From: Ackerman, Mark
Sent: Thursday, January 05, 2017 1:04 PM
To: Coyle, Pat <Pat.Coyle@duke-energy.com>
Cc: Koller, Mark <koller.mark@epa.gov>
Subject: Follow-up Questions Re. FDF Variance Information Submitted in Response to EPA's Nov. 18, 2016

Hi Pat.

I hope your holidays were nice.

Thank you for providing the information requested in our Nov. 18, 2016 letter. We have reviewed the information Duke provided and have some follow-up questions/requests.

1. Can Duke Energy provide the final set of the Edwardsport analytical and flow data in MS Excel instead of PDF?
2. The lab reports for 4/5/2016, 4/6/2016, and 4/8/2016 contain data for "Grey Water Feed Tank." Is this the influent? If so, why aren't these values populated for "Influent" for the mercury, arsenic, selenium, and TDS columns in the data file?
3. The data file includes data for the "Barometric Condenser Condensate" – however, the values populated for 4/5/2016, 4/6/2016, and 4/8/2016 seem to correspond to the lab reports titled "Cryst. Process Cond. Pumps." Should this column really be titled "Crystallizer Process Condensate?"
4. Should the values for mercury for the "Barometric Condenser Condensate" on 4/5/2016, 4/6/2016, and 4/8/2016 be 350 ng/L, 104 ng/L, and 89 ng/L, respectively?
5. We also would like to know more about Duke Energy's response to Question 1 in Duke's transmittal letter dated Dec. 9, 2016. Duke Energy stated that they belatedly became aware that Edwardsport operating personnel collect additional analytical data (e.g., pH and solids) from within the grey water treatment system for process control purposes (including some points that may correspond to the sampling locations EPA asked about). Duke Energy states that it is "unclear but doubtful that this data has been obtained through EPA-approved methods or has been subject to NPDES-appropriate quality control procedures." Therefore, they did not include it in this submittal. Before determining whether to request Duke Energy to provide the data, it would be helpful to learn what parameters were measured, whether EPA-approved analytical methods were used, and which sample points are affected.
6. We've been continuing to review the information already provided and noticed that the reported crystallizer process condensate and barometric condenser condensate flows are much higher than the maximum and average design flow rates. For example, the maximum design flow rate for the barometric condenser condensate is 9 gpm, but the average is reported as 700 gpm.

Mark Ackerman | NPDES Programs Branch, U.S. Environmental Protection Agency | 77 W. Jackson Blvd. (WN-15J), Chicago, IL 60604 | ph: 312-353-4145 | ackerman.mark@epa.gov

Attachment 5

EPA Request for Additional Information (January 9, 2017)

From: Jordan, Ronald
Sent: Monday, January 09, 2017 10:29 AM
To: Coyle, Pat <Pat.Coyle@duke-energy.com>
Subject: RE: Follow-up Questions Re. FDF Variance Information Submitted in Response to EPA's Nov. 18, 2016

Good morning Pat,

Last Thursday, Mark Ackerman sent you a request for some additional information related to Duke Energy's request for an FDF variance at Edwardsport. I'd like to add two questions to Mark's request, to help resolve some confusion we have about the information you already provided.

In the spreadsheet with the "Grey Water Treatment System Flow Rates," the flow rate for the "Concentrator Condensate" is listed as "0" for the "average daily rate" from 5/9/2013 through 5/31/2016. Starting on 6/7/2016, the flow rate is consistently 58 gpm. We have the following questions regarding the flow rate data for the "Concentrator Condensate:"

a) Duke Energy provided mercury analytical data for the "concentrator condensate" on 4/5/2016, 4/6/2016, and 4/8/2016. Please explain how you were able to analyze the "concentrator condensate" wastewater if there was no flow during the day.

b) Please explain why the "Concentrator Condensate" flow rate suddenly increased from "0" to "58" between 5/31/2016 and 6/7/2016. Additionally, please explain how and why the average daily rate of 58 gpm for the "Concentrator Condensate" is greater than the "maximum design flow rate."

Thanks for your assistance with this!

EPA United States Environmental Protection Agency
Ron Jordan
Office of Water
Engineering and Analysis Division
Washington DC
202.566.1003

Attachment 6

Supplemental Information Submitted by Duke Energy – Responses to Questions
(January 24, 2017)

From: Coyle, Pat <Pat.Coyle@duke-energy.com>
Sent: Tuesday, January 24, 2017 4:35:55 PM
To: Ackerman, Mark; Jordan, Ronald
Cc: Gabhart, Raoul Page; Peacock, Mark D; Moody, Rhett Alan; Cheney, Nathan; Woodcox, Garth W.; Henderson, Derek L; Larry Kane (LKane@bgdlegal.com); Ezell, Julie L; Fisher, Sheryl L
Subject: Follow-up Questions Re. FDF Variance Information Submitted in Response to EPA's Nov. 18, 2016 letter

Mark & Ron – Below, please find our responses to your recent follow-up questions about the Edwardsport FDF variance information, submitted 12/9/2016 in answer to EPA's 11/18/2016 request.

Note that this email includes several attachments. Please let me know if you have any problems accessing the documents, and please call if any questions.

Pat Coyle
Duke Energy – Environmental Services
139 E. Fourth St., EM740, Cincinnati, OH 45202-4003
Office: 513-287-2268 / Cell: 513-509-0040

1. Can Duke Energy provide the final set of the Edwardsport analytical and flow data in MS Excel instead of PDF?

   Response: Yes, the final set of Edwardsport analytical and flow data are provided in the attached MS Excel spreadsheets, which have been updated in response to the issues discussed below. In addition, the analytical summary has been updated with: dissolved mercury results for 4/5/2016–4/8/2016 (present on the lab reports, previously submitted); and other results for 9/7/2016 and 9/14/2016 (lab reports attached) not included previously.

2. The lab reports for 4/5/2016, 4/6/2016, and 4/8/2016 contain data for "Grey Water Feed Tank." Is this the influent? If so, why aren't these values populated for "Influent" for the mercury, arsenic, selenium, and TDS columns in the data file?

   Response: The 4/5/2016, 4/6/2016, and 4/8/2016 data for "Grey Water Feed Tank" do represent the influent, and have been added to the summary of Edwardsport analytical data. We wish to provide some clarifying information about the "influent" and "effluent" sampling locations.

   The grey water treatment process receives wastewater from the gasification process as grey water blowdown, which is transferred via the LP Grey Water Feed Pumps into the Grey Water Feed Tanks ("Tanks"). Water from these Tanks is then transferred via the (rather similarly named) Grey Water Feed Pumps into the grey water treatment system. The Grey Water Feed Pumps are therefore the actual "influent" point for the grey water treatment system, though the gasification wastewater is considered to be substantially unchanged between the LP Grey Water Feed Pumps (just upstream of the Tanks) and the Grey Water Feed Pumps (just downstream of the Tanks). In practice, Edwardsport lab technicians have collected samples from either or both of these pump locations to represent the grey water treatment system "influent". We believe the data from both sampling locations are valid for this purpose. Consequently, we have revised the summary table to retain all available "influent" data while also identifying the corresponding sample collection points.

   In a similar fashion, the grey water effluent is represented by data obtained from two related sets of pumps. Water from the grey water treatment process discharges from the Second Pass RO (the final step in treatment) into the RO Permeate Tank, from which it is transferred via the RO Permeate Pumps through a series of three reaction tanks. These reaction tanks were installed for a cyanide destruction step that proved unnecessary for IGCC plant operations. Nevertheless, the tanks remain in place, and water from the RO Permeate Tank flows through them, without further treatment or change, en route to the final discharge point from the grey water treatment system (internal outfall 501 at the Cyanide Destruct Product Pumps). Edwardsport lab technicians have collected samples from either or both the RO Permeate Pumps and Cyanide Destruct Product Pumps (just upstream and just downstream of the reaction tanks) to represent the grey water treatment "effluent". We have revised the summary table to identify the corresponding sample collection points.

3. The data file includes data for the “Barometric Condenser Condensate” – however, the values populated for 4/5/2016, 4/6/2016, and 4/8/2016 seem to correspond to the lab reports titled “Cryst. Process Cond. Pumps.” Should this column really be titled “Crystallizer Process Condensate?”

Response: Yes, the 4/5/2016, 4/6/2016, and 4/8/2016 mercury values for Crystallizer Process Condensate were mistakenly entered in the column for Barometric Condenser Condensate. This has been corrected on the revised analytical data summary.

4. Should the values for mercury for the “Barometric Condenser Condensate” on 4/5/2016, 4/6/2016, and 4/8/2016 be 350 ng/L, 104 ng/L, and 89 ng/L, respectively?

Response: Yes, those are the correct 4/5/2016, 4/6/2016, and 4/8/2016 mercury values for Barometric Condenser Condensate. They were mistakenly overwritten with values for Crystallizer Process Condensate from the same dates. This has been corrected on the revised analytical data summary.

5. We also would like to know more about Duke Energy’s response to Question 1 in Duke’s transmittal letter dated Dec. 9, 2016. Duke Energy stated that they belatedly became aware that Edwardsport operating personnel collect additional analytical data (e.g., pH and solids) from within the grey water treatment system for process control purposes (including some points that may correspond to the sampling locations EPA asked about). Duke Energy states that it is “unclear but doubtful that this data has been obtained through EPA-approved methods or has been subject to NPDES-appropriate quality control procedures.” Therefore, they did not include it in this submittal. Before determining whether to request Duke Energy to provide the data, it would be helpful to learn what parameters were measured, whether EPA-approved analytical methods were used, and which sample points are affected.

Response: A table is attached summarizing the information about various process control data available for the grey water treatment system (parameters, analytical methods, and sampling locations) that was not provided in our earlier response. This data can be provided to EPA if desired. The following is a short explanation for the omission.

After receiving EPA's 11/18/2016 request for additional information, our efforts initially focused on data known to corporate environmental and engineering staff because it was collected to comply with NPDES permit requirements, or to assess Edwardsport's ability to meet recently adopted effluent guidelines. Because EPA's request arrived the week of the Thanksgiving holiday and during a major plant outage, access to key plant people was somewhat limited. The search for available data included interviews with plant lab and operating personnel and, with less than a week to meet EPA's voluntary deadline, Environmental Services became aware of additional analytical data generated by the plant for purposes of process control monitoring of the grey water treatment system. Given the schedule, this data could not be assembled in time for the 12/9/2016 submission to EPA.

As shown in the attached table, the available process monitoring data is varied. Some data resulted from sampling that occurred for only a brief period after IGCC operations began, while in other cases the process monitoring is ongoing (e.g., continuous pH monitoring via in-line probes). QA/QC protocols appropriate for NPDES-reported data would not have been performed on process control samples analyzed by plant lab or operating personnel. However, where the analysis was performed by a contract lab using an EPA-approved method (indicated on the table), we expect that appropriate QA/QC measures were followed. Though any of the referenced data can be provided to EPA if desired, we suspect that mixing data of highly divergent quality (e.g., low-level mercury results with process control data) would lower statistical confidence and reduce the value of any combined analysis.

6. We've been continuing to review the information already provided and noticed that the reported crystallizer process condensate and barometric condenser condensate flows are much higher than the maximum and average design flow rates. For example, the maximum design flow rate for the barometric condenser condensate is 9 gpm, but the average is reported as 700 gpm.

Response: Please disregard the flow information originally provided for Crystallizer Process Condensate and Barometric Condenser Condensate. We have subsequently determined that the flow data reported is not descriptive of these wastestreams.

The barometric condenser data was mistakenly taken from a flow transmitter that is located on the Barometric Condenser Pumps recirculation line instead of on the bleed line (or blowdown line) running from the Barometric Condenser recirculation line to the Condensate Cooler. (See Drawing M6-16-20007, attached.) There is no flow transmitter on the Barometric Condenser Condensate blowdown line that runs to the Condensate Cooler.

Through an internal misunderstanding, Plant Operations accidently provided operational flow data for the Cold Press Filter Feed Pump flow that feeds the filter presses rather than for the Crystallizer Process Condensate flow. There is no flow transmitter on the Crystallizer Process Condensate Pumps discharge line or on the line connecting the Crystallizer Process Condensate Pumps discharge line to the Condensate Cooler. (See Drawing M6-16-20024, attached.) The summary of grey water flow data has been amended to correct this.

7. Grey Water Treatment System Flow Rates − In the spreadsheet with the "Grey Water Treatment System Flow Rates," the flow rate for the "Concentrator Condensate" is listed as "0" for the "average daily rate" from 5/9/2013 through 5/31/2016. Starting on 6/7/2016, the flow rate is consistently 58 gpm. We have the following questions regarding the flow rate data for the "Concentrator Condensate:"

a) Duke Energy provided mercury analytical data for the "concentrator condensate" on 4/5/2016, 4/6/2016, and 4/8/2016. Please explain how you were able to analyze the "concentrator condensate" wastewater if there was no flow during the day.

b) Please explain why the "Concentrator Condensate" flow rate suddenly increased from "0" to "58" between 5/31/2016 and 6/7/2016. Additionally, please explain how and why the average daily rate of 58 gpm for the "Concentrator Condensate" is greater than the "maximum design flow rate."

Response: While gathering the data for the response to EPA's information request, an internal miscommunication occurred about the desired data. The flow information provided with that response mistakenly came from the Concentrator #1/#2 Product Pumps instead of the Concentrator #1/#2 Condensate Pumps. Regardless of that miscommunication, a closer examination of the flow schematics shows that there is no dedicated flow transmitter on the line running from the Concentrator #1/#2 Condensate Flash Tanks to the Condensate Cooler and, thus, there is no capability to measure the flow of Concentrator Condensate to the Condensate Cooler.

The flow transmitters off Concentrator #1 Condensate Pumps and Concentrator #2 Condensate Pumps are located on the discharge lines from these pumps prior to the junction of the recirculation line for the Condensate Flash Tank and the bleed line (or blowdown line) running to the Condensate Cooler. (See Drawings M6-16-20009 and M6-16-20014, attached.) The summary of grey water flow data has been amended to correct this.

Attachment 7

Supplemental Information Submitted by Duke Energy – Grey Water Analytical Data (January 24, 2017)

Edwardsport Grey Water Treatment Analyses, 2013-2016

(Revised 1/23/2017)

Note: Metals results represent the total recoverable metal unless otherwise indicated.
Note: Values below detection are marked '<'. Value shown is the lab detection limit.

	Mercury (ng/l)										Arsenic (ug/l)						Selenium (ug/l)					
		Influent							Effluent			Influent			Effluent			Influent			Effluent	
Sample date:	Filtered Water	LP Grey Water Feed Pumps	Grey Water Feed Pumps	Concentrator Condensate	Crystallizer Steam Condensate	Crystallizer Process Condensate	Barometric Condenser Condensate	Condensate Trim Cooler	RO Permeate Pumps	Outfall 501 - Cyanide Destruct Pumps	Filtered Water	LP Grey Water Feed Pumps	Grey Water Feed Pumps	Condensate Trim Cooler	RO Permeate Pumps	Outfall 501 - Cyanide Destruct Pumps	Filtered Water	LP Grey Water Feed Pumps	Grey Water Feed Pumps	Condensate Trim Cooler	RO Permeate Pumps	Outfall 501 - Cyanide Destruct Pumps
5/9/2013																< 1.00						7.0
5/23/2013																< 2.00						< 2.0
6/6/2013																< 2.00						< 2.0
6/13/2013																< 2.00						< 2.0
7/22/2013										2.08												
7/24/2013																2						4.0
7/31/2013																< 1.00						< 1.0
8/2/2013																< 1.0						< 1.0
8/8/2013										9.58												
8/21/2013																15						< 10.0
9/5/2013																< 10.00						< 10.0
9/25/2013																< 10.00						< 10.0
10/3/2013										2.53												
10/8/2013																< 10.0						< 10.0
10/17/2013																< 1.0						< 10.0
9/8/2015	0.540	6.55							12.8		< 1.0	1,100			< 1.0		< 1.0	260			< 1.0	
9/10/2015	< 0.50	15.8							5.25		< 1.0	120			< 1.0		< 1.0	160			< 1.0	
9/15/2015	< 0.50	10.8							10.3		< 2.0	120			< 2.0		< 2.0	320			< 2.0	
9/17/2015	< 0.50	21.2							6.55		< 2.0	130			< 2.0		< 2.0	130			< 2.0	
9/22/2015	< 0.50	22.0							10.8		< 1.0	31			< 1.0		< 1.0	78			< 1.0	
9/24/2015	< 0.50	23.4							11.5		< 1.0	63			< 1.0		< 1.0	87			< 1.0	
9/29/2015	< 0.50	44.4							6.40		< 1.0	67			< 1.0		< 1.0	66			< 1.0	
10/1/2015	< 0.50	7.35							3.92		< 1.0	42			< 1.0		< 1.0	80			< 1.0	
10/6/2015	< 0.50	15.6							2.40		< 1.0	33			< 1.0		< 1.0	140			< 1.0	
10/8/2015	< 0.50	11.8							5.79		< 1.0	38			< 1.0		< 1.0	160			10.0	
10/13/2015	< 0.50	30.4							3.05		< 1.0	210			< 1.0		< 1.0	140			< 1.0	
10/13/2015		0.694 (dissolved)							3.61 (dissolved)													
10/15/2015	< 0.50	59.5							0.877		< 1.0	230			< 1.0		< 1.0	110			< 1.0	
10/15/2015		0.694 (dissolved)							0.938 (dissolved)													
4/5/2016			938	7.03	< 0.50	3.31	350.0	15.60	4.00	4.74			210			< 1.0			130			2.9
4/5/2016			< 0.52 (dissolved)	< 0.51 (dissolved)	< 0.50 (dissolved)	0.653 (dissolved)	203 (dissolved)	< 0.51 (dissolved)	3.64 (dissolved)	2.41 (dissolved)												
4/6/2016			6,200	7.25	< 0.50	1.34	104.0	16.30	6.47	8.39			330			< 1.0			250			4.1
4/6/2016			4.92 (dissolved)	0.826 (dissolved)	< 0.50 (dissolved)	< 0.52 (dissolved)	44.1 (dissolved)	< 0.51 (dissolved)	6.42 (dissolved)	0.860 (dissolved)												
4/8/2016			1,000	1.72	0.59	1.15	89.0	8.88	5.20	3.09			260			< 1.0			120			3.8
4/8/2016			< 0.52 (dissolved)	< 0.51 (dissolved)	< 0.50 (dissolved)	0.718 (dissolved)	5.09 (dissolved)	0.622 (dissolved)	1.69 (dissolved)	1.48 (dissolved)												
4/14/2016																						
5/27/2016										17.8						< 1.0						14.2
5/31/2016										4.46						< 1.0						< 1.0
6/7/2016	< 0.50									1.51						< 1.0						< 1.0
6/15/2016										< 0.50						< 1.0						< 1.0
7/6/2016										3.53						< 1.0						1.1
7/13/2016										1.44						< 1.0						1.3
8/3/2016	< 0.50									< 0.50						< 1.0						< 1.0
8/10/2016										4.07						< 1.0						7.2
9/7/2016		13.8	39.0					25.8	4.73	2.05		160	361	1.20	< 1.0	< 1.0		95.9	82.6	4.12	< 1.0	1.5
9/14/2016		9.24	21.8					8.87	1.79	0.780		106	594	1.06	< 1.0	< 1.0		108	33.2	2.60	< 1.0	< 1.0
10/1/2016										1.79						< 1.0						1.0
Maximum	**0.54**		**6,200**	**7.25**	**0.59**	**3.31**	**350.0**	**25.8**		**17.8**	**< 2.0**		**1,100**	**1.20**		**15.0**	**2**		**320**	**4.12**		**14.2**
Average	**0.50**		**446.9**	**5.3**	**< 0.53**	**1.93**	**181.0**	**15.1**		**5.02**	**< 1.2**		**221.3**	**1.13**		**2.2**	**1.2**		**134.2**	**3.36**		**3.4**
Minimum	**< 0.50**		**6.55**	**1.7**	**< 0.50**	**1.15**	**89.0**	**8.87**		**< 0.50**	**< 1.0**		**31.0**	**1.06**		**< 1.0**	**< 1.0**		**33.2**	**2.60**		**< 1.0**
No. of results	**14**		**19**	**3**	**3**	**3**	**3**	**5**		**34**	**12**		**19**	**2**		**40**	**12**		**19**	**2**		**40**

	Total Disolved Solids (mg/l)						Aluminum (mg/l)	Antimony (mg/l)	Barium (mg/l)	Beryllium (mg/l)	Cadmium (mg/l)	Chloride (mg/l)	Chromium (mg/l)	Copper (mg/l)	Cyanide, Total (mg/l)	Cyanide, Free (mg/l)	Fluoride (mg/l)	Iron (mg/l)	Lead (mg/l)	Manganese (mg/l)	Ammonia (NH3) as N (mg/l)	Nickel (mg/l)
	Filtered Water	Influent		Condensate Trim Cooler	Effluent		Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501
Sample date:		LP Grey Water Feed Pumps	Grey Water Feed Pumps		RO Permeate Pumps	Outfall 501 - Cyanide Destruct Pumps																
5/9/2013							0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.700	< 0.001	< 0.001	0.209	0.108	1.360	0.001	< 0.001	< 0.001	1.15	< 0.001
5/23/2013							0.008	< 0.002	< 0.002	< 0.002	< 0.002	< 0.070	< 0.002	< 0.002	0.505	0.340	0.880	0.004	< 0.002	< 0.002	1.14	< 0.002
6/6/2013							0.011	< 0.002	< 0.002	< 0.002	< 0.002	< 0.070	< 0.002	0.003	0.845	0.798	0.071	0.007	< 0.002	0.005	0.76	0.002
6/13/2013							0.006	< 0.002	< 0.002	< 0.002	< 0.002	< 0.070	< 0.002	0.003	0.210	< 0.001	0.599	0.011	< 0.002	< 0.002	1.14	0.002
7/22/2013																						
7/24/2013							0.009	< 0.001	0.002	< 0.001	< 0.001	0.120	< 0.001	< 0.001	3.750	3.060	0.240	0.016	0.004	< 0.001	1.27	0.001
7/31/2013							0.061	0.017	0.003	< 0.001	< 0.001	< 0.070	0.001	< 0.001	0.280	0.260	0.260	0.058	< 0.001	0.001	1.49	< 0.001
8/2/2013							0.295	0.006	0.003	< 0.001	< 0.001	< 0.070	< 0.001	0.001	0.250	0.243	0.270	0.012	< 0.001	< 0.001	1.10	< 0.001
8/8/2013																						
8/21/2013							0.020	< 0.010	< 0.010	< 0.010	< 0.010	< 0.070	< 0.010	< 0.010	0.880	0.868	0.050	0.043	0.030	< 0.010	1.05	< 0.010
9/5/2013							0.016	< 0.010	< 0.010	< 0.010	< 0.010	< 0.070	< 0.010	< 0.010	0.250	0.229	< 0.040	0.054	< 0.010	< 0.010	0.85	< 0.010
9/25/2013							0.040	< 0.010	< 0.010	< 0.010	< 0.010	< 0.070	< 0.010	< 0.010	0.095	0.087	0.142	0.036	< 0.010	< 0.010	< 0.20	< 0.010
10/3/2013																						
10/8/2013							0.028	< 0.010	< 0.010	< 0.010	< 0.010	< 0.070	< 0.010	< 0.010	0.030	0.029	0.096	0.036	< 0.010	< 0.010	0.56	< 0.010
10/17/2013							0.057	< 0.001	< 0.001	< 0.001	< 0.010	< 0.070	< 0.010	< 0.010	0.200	0.191	0.071	0.013	< 0.010	< 0.010	1.52	< 0.010
9/8/2015	300	2,540			20																	
9/10/2015	300	3,020			40																	
9/15/2015	120	2,560			< 10																	
9/17/2015	280	2,090			20																	
9/22/2015	324	2,200			10																	
9/24/2015	322	2,140			< 10																	
9/29/2015	420	2,700			32																	
10/1/2015	336	2,980			20																	
10/6/2015	340	2,680			20																	
10/8/2015	380	1,660			14																	
10/13/2015	320	2,230			222																	
10/13/2015																						
10/15/2015	340	2,120			60																	
10/15/2015																						
4/5/2016			1,410			34																
4/5/2016																						
4/6/2016			1,360			72																
4/6/2016																						
4/8/2016			870			42																
4/8/2016																						
4/14/2016		790	586	1,760	19																	
5/27/2016						< 10																
5/31/2016						< 10																
6/7/2016						24																
6/15/2016						< 10																
7/6/2016						< 10																
7/13/2016						< 10																
8/3/2016						< 10																
8/10/2016						< 10																
9/7/2016		570	2,600	1,400	< 25	< 10																
9/14/2016		830	4,200	1,800	< 25	< 10																
10/1/2016						30																
Maximum	**420**		**4,200**	**1,800**		**222**	**0.295**	**0.017**	**0.010**	**0.010**	**0.01**	**0.7**	**0.01**	**0.01**	**3.75**	**3.06**	**1.36**	**0.058**	**0.03**	**0.01**	**1.52**	**0.010**
Average	**315**		**2,006**	**1,653**		**28.9**	**0.0**	**0.0060**	**0.0047**	**0.0043**	**0.0**	**0.1**	**0.0**	**0.0**	**0.6**	**0.5**	**0.3**	**0.024**	**0.007**	**0.0**	**1.0**	**0.005**
Minimum	**120**		**570**	**1,400**		**< 10.0**	**0.0**	**< 0.00**	**< 0.0**	**< 0.00**	**< 0.0**	**< 0.1**	**< 0.0**	**< 0.0**	**0.030**	**< 0.001**	**< 0.04**	**0.001**	**< 0.00100**	**< 0.0**	**< 0.2**	**< 0.001**
No. of results	**12**		**21**	**3**		**29**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**

Sample date:	Oil & Grease (mg/l)	pH (SU)	Phenol (mg/l)	Silver (mg/l)	Solids, Total Suspended (mg/l)	Sulfate (mg/l)	Sulfide (as S) (mg/l)	Thallium (mg/l)	Zinc (mg/l)
	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501	Effluent - Outfall 501
5/9/2013	< 5.00	7.30	< 0.005	< 0.001	< 4.00	< 3.000	0.025	< 0.001	0.010
5/23/2013	< 5.00	8.30	0.012	< 0.002	< 4.00	0.800	0.095	< 0.002	0.019
6/6/2013	< 5.00	8.00	0.009	< 0.002	< 4.00	0.400	13.400	< 0.002	0.008
6/13/2013	< 5.00	8.00	0.008	< 0.002	< 4.00	< 0.300	0.163	< 0.002	0.011
7/22/2013									
7/24/2013	< 5.00	7.90	< 0.005	< 0.001	< 4.00	0.600	6.300	0.010	0.014
7/31/2013	< 5.00	8.40	0.084	< 0.001	< 4.00	0.400	0.352	< 0.001	0.018
8/2/2013	< 5.00	8.10	0.072	< 0.001	< 4.00	1.000	0.654	< 0.001	0.025
8/8/2013									
8/21/2013	< 5.00	7.47	< 0.005	< 0.010	< 4.00	0.456	1.580	0.032	0.025
9/5/2013	< 5.00	8.70	0.020	< 0.010	< 4.00	1.120	3.450	< 0.010	0.034
9/25/2013	< 5.00	9.50	0.009	< 0.010	< 4.00	0.872	< 0.005	< 0.010	0.038
10/3/2013									
10/8/2013	< 5.00	6.70	0.012	< 0.010	< 4.00	0.625	0.013	< 0.010	0.039
10/17/2013	< 5.00	7.30	< 0.005	< 0.010	< 4.00	< 0.300	0.803	< 0.010	0.019
9/8/2015									
9/10/2015									
9/15/2015									
9/17/2015									
9/22/2015									
9/24/2015									
9/29/2015									
10/1/2015									
10/6/2015									
10/8/2015									
10/13/2015									
10/13/2015									
10/15/2015									
10/15/2015									
4/5/2016									
4/5/2016									
4/6/2016									
4/6/2016									
4/8/2016									
4/8/2016									
4/14/2016									
5/27/2016									
5/31/2016									
6/7/2016									
6/15/2016									
7/6/2016									
7/13/2016									
8/3/2016									
8/10/2016									
9/7/2016									
9/14/2016									
10/1/2016									
Maximum	**< 5.00**	**9.5**	**0.084**	**< 0.010**	**< 4.0**	**1.120**	**13.4**	**0.032**	**0.039**
Average	**< 5.00**	**8.0**	**0.021**	**< 0.005**	**< 4.0**	**0.82**	**2.24**	**0.008**	**0.022**
Minimum	**< 5.00**	**6.7**	**< 0.005**	**< 0.001**	**< 4.0**	**< 0.30**	**< 0.005**	**< 0.001**	**0.008**
No. of results	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**

Attachment 8

Supplemental Information Submitted by Duke Energy – Grey Water Treatment System Flow Rate Data (January 24, 2017)

Grey Water Treatment System Flow Rates	Grey Water Treatment System Influent (gpm)	Concentrator Condensate (gpm)	Crystallizer Steam Condensate (gpm)	Crystallizer Process Condensate (gpm)	Barometric Condenser Condensate (gpm)	Condensate Trim Cooler (gpm)	Greywater Treatment System Effluent (gpm)
	Design						
Design Flow Stream #:	**1 & 21**	**8 & 28**	**56**	**48**	**58**	**71**	**104**
Design: 750 gpm, 175 Deg. F:	450 + 300	476 + 317	34	37	9	857	746.5
Design: 450 gpm, 175 Deg. F:	450 + 0	476 + 0	20	22	6	516	-
	Operational						
PI Tags:	16FI0016A/16FI0016B	16FI1082/16FI2082	-	-	-	16FI0413	-
Note:	-	Flow Transmitter is located upstream of the condensate pump recycle and several other lines from process, including the bleed to condensate cooler. See DWGS: M6-16-2009 & M6-16-20014	No Flow Data Available	No Flow Data Available	**Flows Removed:** The flow transmitter is downstream of the piping to the Condensate Cooler. The flow data originally provided is misleading in that it captures the barometric condenser condensate pump recirc, but does not capture the bleed to condensate cooler. See DWG: M6-16-20007	-	-
Average daily rate, sample date: 5/9/2013	237	708	-	-	-	191	56*
5/23/2013	256	697	-	-	-	327	250*
6/6/2013	451	744	-	-	-	369	354*
6/13/2013	336	60	-	-	-	25	229*
7/22/2013	240	345	-	-	-	260	245
7/24/2013	236	344	-	-	-	176	347*
7/31/2013	245	345	-	-	-	327	354*
8/2/2013	239	345	-	-	-	329	299*
8/8/2013	261	301	-	-	-	168	154
8/21/2013	270	345	-	-	-	387	369
8/25/2013	259	345	-	-	-	362	333*
9/5/2013	504	554	-	-	-	342	472*
9/25/2013	263	345	-	-	-	372	326*
10/3/2013	212	345	-	-	-	18	11
10/8/2013	262	349	-	-	-	380	299*
10/17/2013	356	345	-	-	-	508	493*
9/8/2015	413	846	-	-	-	435	458
9/10/2015	424	842	-	-	-	432	452
9/15/2015	415	838	-	-	-	430	427
9/17/2015	414	835	-	-	-	427	448
9/22/2015	416	837	-	-	-	433	430
9/24/2015	426	833	-	-	-	461	469
9/29/2015	412	840	-	-	-	437	433
10/1/2015	417	832	-	-	-	428	420
10/6/2015	413	843	-	-	-	439	425
10/8/2015	413	847	-	-	-	443	435
10/13/2015	383	812	-	-	-	409	411
10/15/2015	189	805	-	-	-	417	417
4/5/2016	228	153	-	-	-	406	390
4/6/2016	252	47	-	-	-	430	347*
4/8/2016	249	320	-	-	-	448	444
4/14/2016	262	489	-	-	-	423	412
5/27/2016	390	547	-	-	-	434	222*
5/31/2016	264	344	-	-	-	295	250*
6/7/2016	381	483	-	-	-	422	444*

Grey Water Treatment System Flow Rates	Grey Water Treatment System Influent (gpm)	Concentrator Condensate (gpm)	Crystallizer Steam Condensate (gpm)	Crystallizer Process Condensate (gpm)	Barometric Condenser Condensate (gpm)	Condensate Trim Cooler (gpm)	Greywater Treatment System Effluent (gpm)
6/15/2016	268	362	-	-	-	310	313*
7/6/2016	401	507	-	-	-	444	451*
7/13/2016	368	466	-	-	-	401	382*
8/3/2016	305	397	-	-	-	341	229*
8/10/2016	428	525	-	-	-	462	472*
9/7/2016	419	512	-	-	-	497	569*
9/14/2016	410	491	-	-	-	472	451*
10/1/2016	285	235	-	-	-	293	181*

Note: System effluent flow values in gpm marked with an asterisk (*) have been back-calculated from NPDES-reported MGD values.

Attachment 9

Supplemental Information Submitted by Duke Energy – Grey Water Treatment System Additional Process Monitoring Data Available (January 24, 2017)

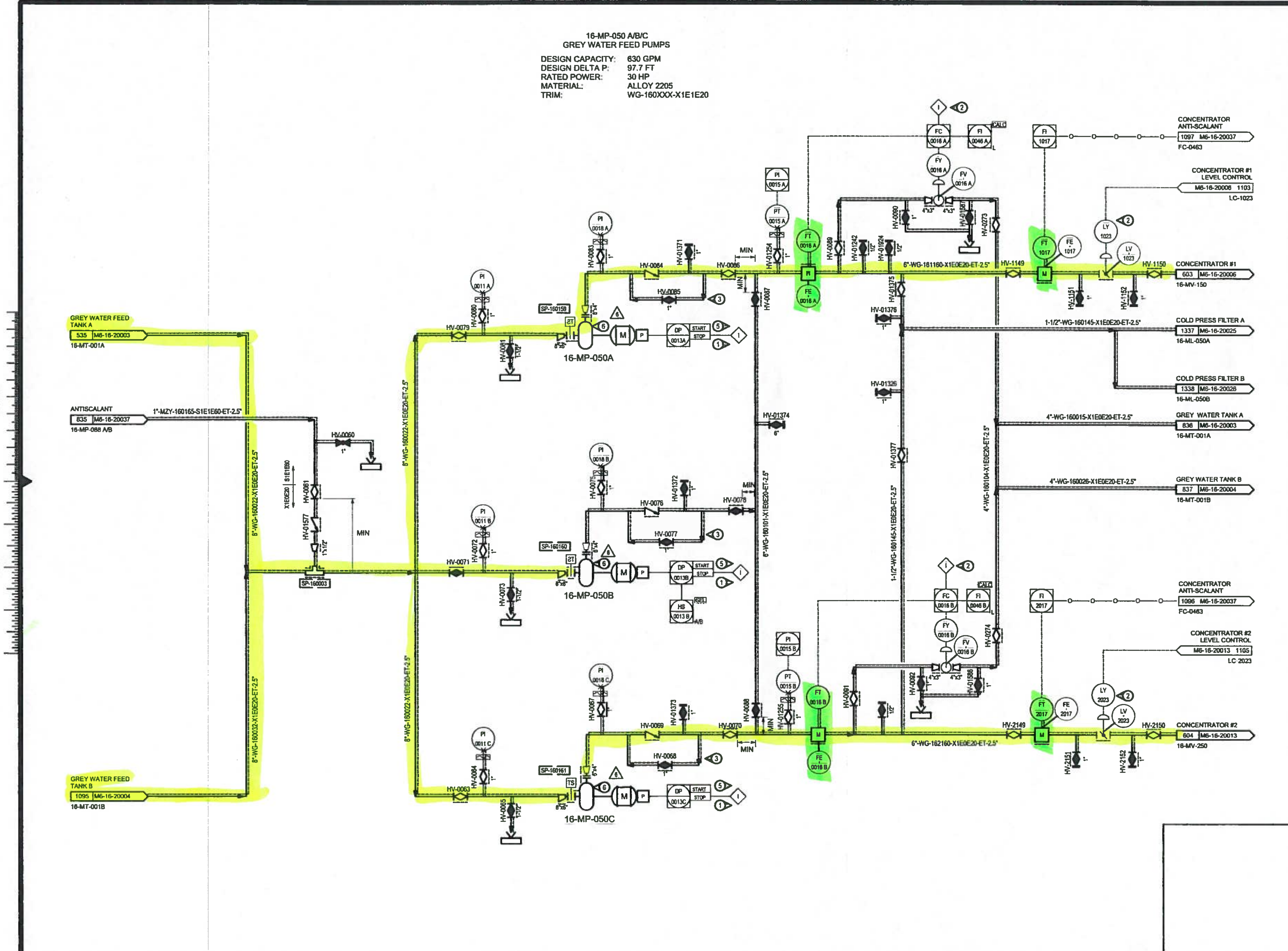
Edwardsport Grey Water Treatment System − Additional Process Monitoring Data, 2013-2016

	A − Influent (LP Grey Water Feed Pumps)	B − Concentrator Condensate Pumps	C − Crystallizer Steam Condensate Pumps	D − Crystallizer Process Condensate Pumps	E − Barometric Condenser Pumps	G − Effluent (RO Permeate Pumps)	G − Effluent (Cyanide Destruct Product Pumps)
pH	May 2013−present via hand-held meter	May 2013−present via in-line probe; May−Sept. 2013 via hand-held meter			May 2013−present via in-line probe; May−Sept. 2013 via hand-held meter	May 2013−present via in-line probe; May−Sept. 2013 via hand-held meter	May 2013−present via in-line probe
Conductivity	May 2013−present via bench-top meter	May 2013−present via in-line probe and bench-top meter	May 2013−present via in-line probe	May 2013−present via in-line probe	May−Sept. 2013 via bench-top meter	May−Sept. 2013 via bench-top meter	
Oxidation-reduction potential (ORP)							May 2013−present via in-line probe
Solids, %	May 2013−present via MA35 infrared moisture analyzer				May−Sept. 2013 via MA35 infrared moisture analyzer	May−Sept. 2013 via MA35 infrared moisture analyzer	
Solids, Total Dissolved	May 2013−present via SM-2540C						
Solids, Total Suspended	May 2013−present via SM-2540D						
Ammonium	May 2013−Feb. 2015 via ion chromatography	May 2013−Feb. 2015 via ion chromatography			May−Sept. 2013 via ion chromatography	May−Sept. 2013 via ion chromatography	
Calcium	May 2013−Feb. 2015 via ion chromatography	May 2013−Feb. 2015 via ion chromatography			May−Sept. 2013 via ion chromatography	May−Sept. 2013 via ion chromatography	
Chloride	May 2013−Feb. 2015 via ion chromatography	Sept.−Oct. 2013 via ion chromatography			May−Sept. 2013 via ion chromatography		
Formate	May 2013−present via SW846-9056 (Mod); May 2013−Sept. 2014 via ion chromatography	May 2013−present via SW846-9056 (Mod); June 2013−March 2014 via ion chromatography			May−Sept. 2013 via SW846-9056 (Mod)	May−Sept. 2013 via SW846-9056 (Mod) and ion chromatography	
Cyanide, Free	May 2013−present via SM-4500-CN G or OIA-1677-09	May−Sept. 2013 via SM 4500-CN G or OIA-1677-09				May 2013−present via SM-4500-CN G or OIA-1677-09	
Cyanide, Total	May 2013−present via SM-4500-CN E	May−Sept. 2013 via SM-4500-CN E				May 2013−present via SM-4500-CN E	
Potassium	May 2013−Feb. 2015 via ion chromatography	May 2013−Jan. 2015 via ion chromatography			May−Sept. 2013 via ion chromatography	May−Sept. 2013 via ion chromatography	

	A − Influent (LP Grey Water Feed Pumps)	B − Concentrator Condensate Pumps	C − Crystallizer Steam Condensate Pumps	D − Crystallizer Process Condensate Pumps	E − Barometric Condenser Pumps	G − Effluent (RO Permeate Pumps)	G − Effluent (Cyanide Destruct Product Pumps)
Silica	May 2013−present via Hach DR3800 meter; Sept. 2014 via SM-8186	May 2013−present via Hach DR3800 meter			May−Sept. 2013 via Hach DR3800 meter	May−June 2013 via Hach DR3800 meter	
Sodium	May 2013−Feb. 2015 via ion chromatography	Aug. 2013−Oct. 2014 via ion chromatography			Aug. 2013 via ion chromatography	May−Sept. 2013 via ion chromatography	
Sulfate	May 2013−Sept. 2014 via ion chromatography	May 2013−Feb. 2015 via ion chromatography			May−Sept. 2013 via ion chromatography	May−Sept. 2013 via ion chromatography	

Attachment 10

Supplemental Information Submitted by Duke Energy – Grey Water Treatment System Process and Instrumentation Diagrams (January 24, 2017)



no	date	by	chd	description
0	06/04/10	SSK	CAD	ISSUED FOR CONSTRUCTION
1	07/23/10	SSK	CAD	REVISED AS NOTED
2	04/22/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0033
3	05/13/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0035
4	08/25/11	SSK	TPC	ISSUED FOR 0GWT CONST. T/O
5	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS
6	07/22/14	JDB	JW	ADDED NOTE 6 DO2015-00013

NOTES:

1. PUMPS TO STOP ON LOW LOW GREY WATER FEED TANK A(B).
2. PUMP A OR C OFF, CLOSES FV-0016A (FV-0016B) AND LY-1023 (LY-2023). PUMP B SELECTED TO TRAIN 1 OR 2, INTERLOCK ON PUMP B STOP ONLY AFFECTS THE SELECTED TRAIN VALVES.
3. PUMP FREEZE PROTECTION.
4. PLUG VALVES ARE PTFE LINED UNLESS OTHERWISE NOTED.
5. SEAL WATER HEADER PRESSURE LOW-LOW FOR 10 SECS WILL TRIP PUMPS 16-MP-050 A/B/C.
6. SEAL WATER VALVES LOCATED ON P&ID M6-16-20072

9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400

date	drawn
Sep 29, 2009	S. KAPHINGST
designed	checked
HPD	C. DEMMEL

Duke Energy. HPD

IGCC GREY WATER TREATMENT

Process & Instrumentation Diagram
GREY WATER FEED PUMPS

project	contract
52240	5.8321

drawing	rev.
M6-16-20005	6

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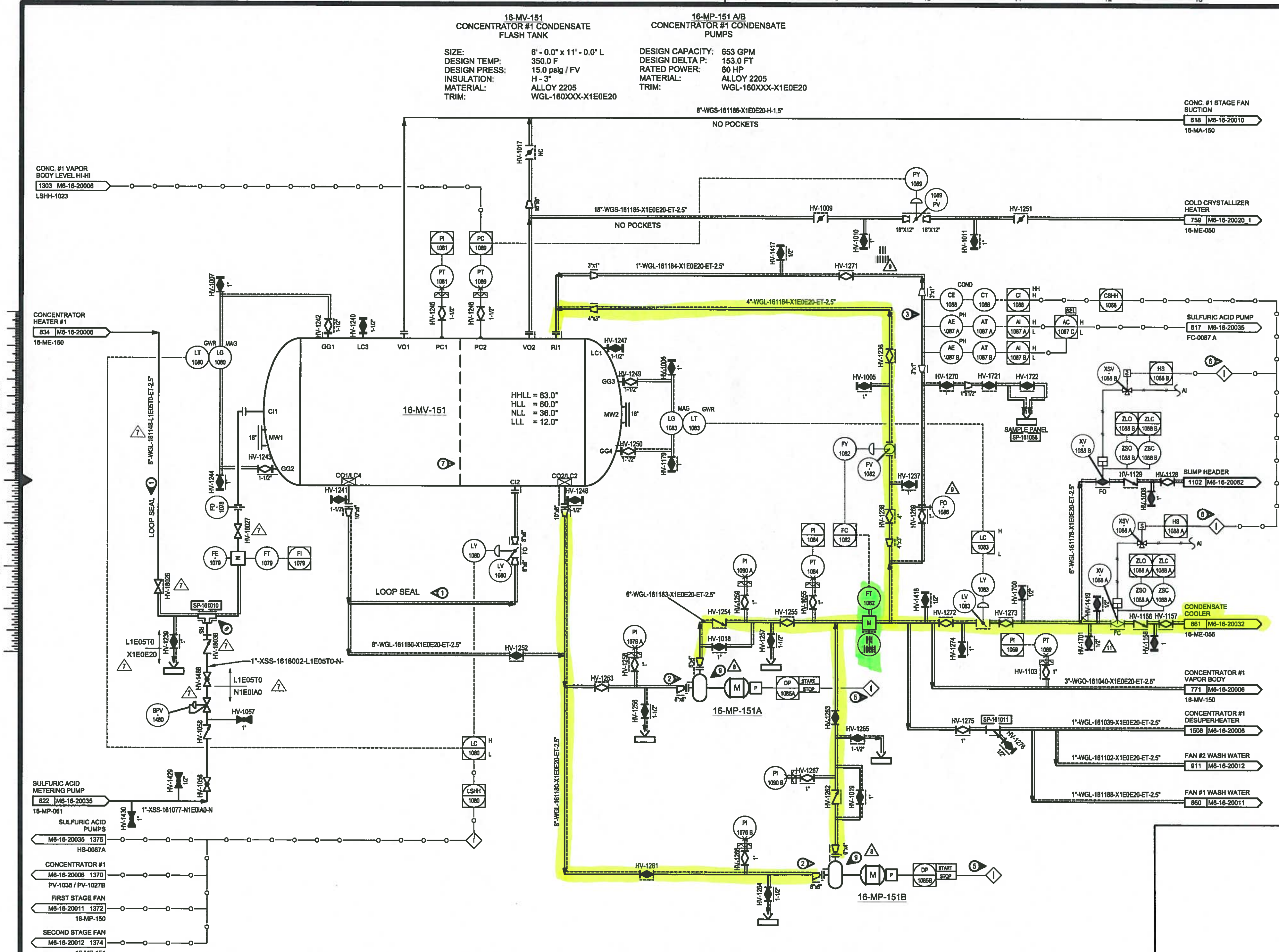

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2	11/05/10	SSK	CAD	REVISED AS NOTED
3	04/22/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0033
4	11/28/11	AAH	TPC	ISSUED FOR 0GWC CONST. T/O
5	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS
6	09/04/12	SSK	TPC	CONFORMING TO CONST. RECORDS
7	04/17/14	JDB	JC	AS BUILT MOC 2014014-001
8.	07/22/14	JDB	JW	ADDED NOTE 9 DO2015-00013
9.	12/15/14	JDB	JB	RELOCATED FO 1086 MOC 2014279-001
10.	09/02/16	RLH	-	ISSUED FOR UPDATE PER MOC# M2016167-006
11.	10/13/16	NC	-	REF MOC# M2016167-012

NOTES:

1. 6'-0" OR MAXIMIZE DISTANCE.
2. PROVIDE STARTUP SCREEN (REMOVE AFTER INTIAL OPERATION).
3. PH AND CONDUCTIVITY PROBES TO BE AT LOW POINT TO REMAIN FULL AT ALL TIMES.
4. PLUG VALVES ARE PTFE LINED UNLESS OTHERWISE NOTED.
5. SEAL WATER HEADER PRESSURE LOW-LOW FOR 10 SECS TRIPS PUMPS 16-MP-151 A/B.
6. CI-1087 HH FOR 10 SECS OPENS HV-1088B AND CLOSES HV-1088A. ONCE ALARM IS CLEARED FOR 30 SECS, OPENS HV-1088A AND CLOSES HV-1088B.
7. DIVIDED TANK.
8. STATIC MIXER.
9. SEAL WATER VALVES LOCATED ON P&ID M6-16-20072_1

Burns & McDonnell
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400

date	detailed
Aug 28, 2009	S. KAPHINGST
designed	checked
HPD	C. DEMMEL

Duke Energy. HPD

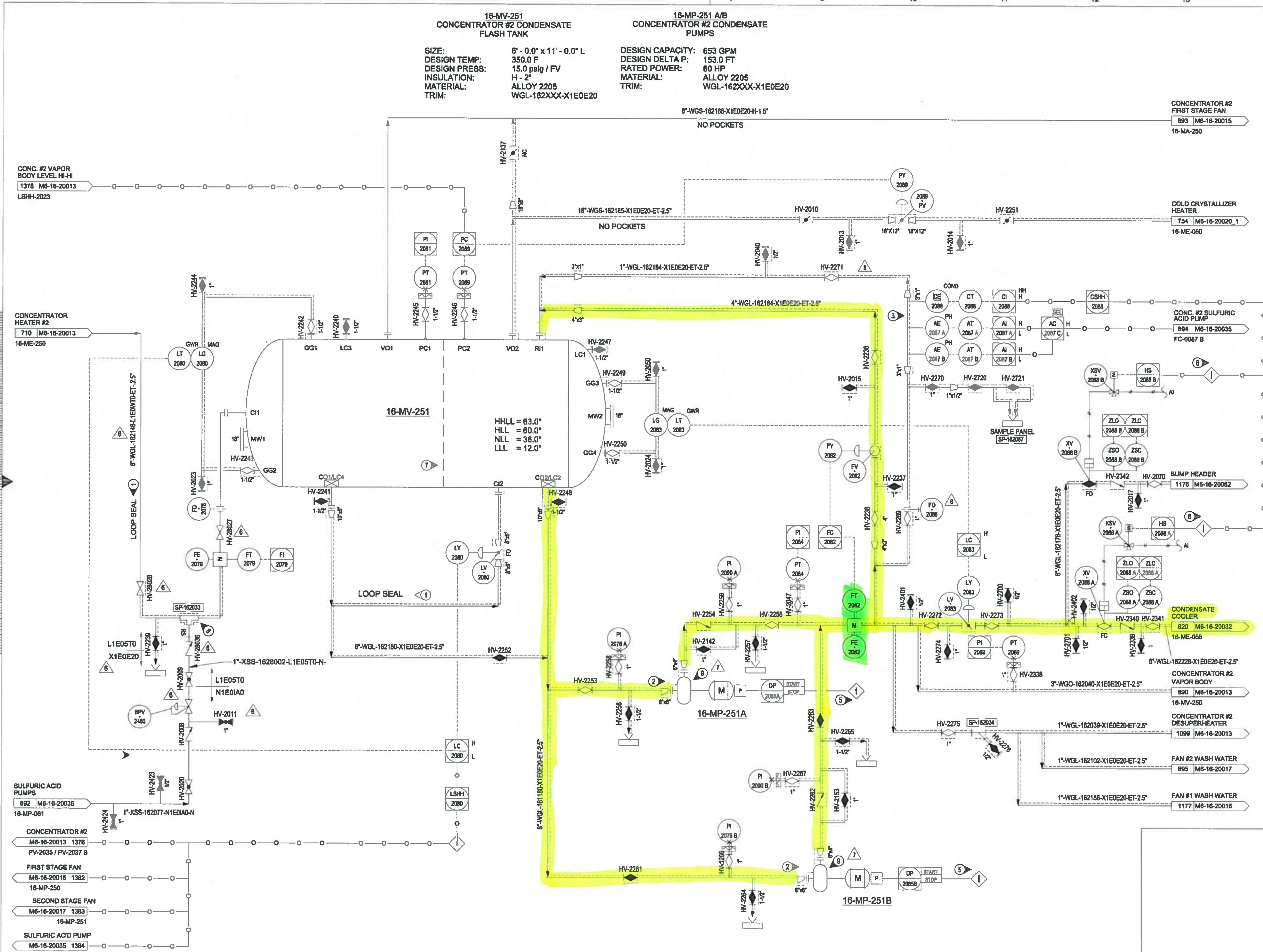
IGCC GREY WATER TREATMENT

Process & Instrumentation Diagram
CONCENTRATOR #1
CONDENSATE FLASH TANK

project	contract
52240	5.8321

drawing: M6-16-20009 rev. 11

file: \Edwardsport\Unit1\52240-M6-16-20009.pid



no.	date	by	chd	description
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1	07/23/10	SSK	CAD	REVISED AS NOTED
2	11/05/10	SSK	CAD	REVISED AS NOTED
3	04/22/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0033
4	11/28/11	AAH	TPC	ISSUED FOR 0GWC CONST. T/O
5	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS
6	04/17/14	JDB	JC	AS BUILT MOC 2014014-001
7.	07/22/14	JDB	JW	ADDED NOTE 9 DO2015-00013
8.	12/15/14	JDB	JB	RELOCATED FO 2086 MOC 2014279-001
9.	09/02/16	RLH	-	ISSUED FOR UPDATE PER MOC# M2016167-007

NOTES:

1. 6'-0" OR MAXIMIZE DISTANCE.
2. PROVIDE STARTUP SCREEN (REMOVE AFTER INITIAL OPERATION).
3. PH AND CONDUCTIVITY PROBES TO BE AT LOW POINT TO REMAIN FULL AT ALL TIMES.
4. PLUG VALVES ARE PTFE LINED UNLESS OTHERWISE NOTED.
5. SEAL WATER HEADER PRESSURE LOW-LOW FOR 10 SECS TRIPS PUMPS 16-MP-251 A/B.
6. CI-2087 HH FOR 10 SECS OPENS HV-2088B AND CLOSES HV-2088A. ONCE ALARM IS CLEARED FOR 30 SECS, OPENS HV-2088A AND CLOSES HV-2088B.
7. DIVIDED TANK.
8. STATIC MIXER.
9. SEAL WATER VALVES LOCATED ON P&ID M6-16-20072_1

Burns & McDonnell
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400

date	detailed
Aug 28, 2009	S. KAPHINGST
designed	checked
HPD	C. DEMMEL

Duke Energy. HPD

IGCC GREY WATER TREATMENT

Process & Instrumentation Diagram
CONCENTRATOR #2
CONDENSATE FLASH TANK

project	contract
52240	5.8321

drawing	rev.
M6-16-20014	9

sheet of sheets

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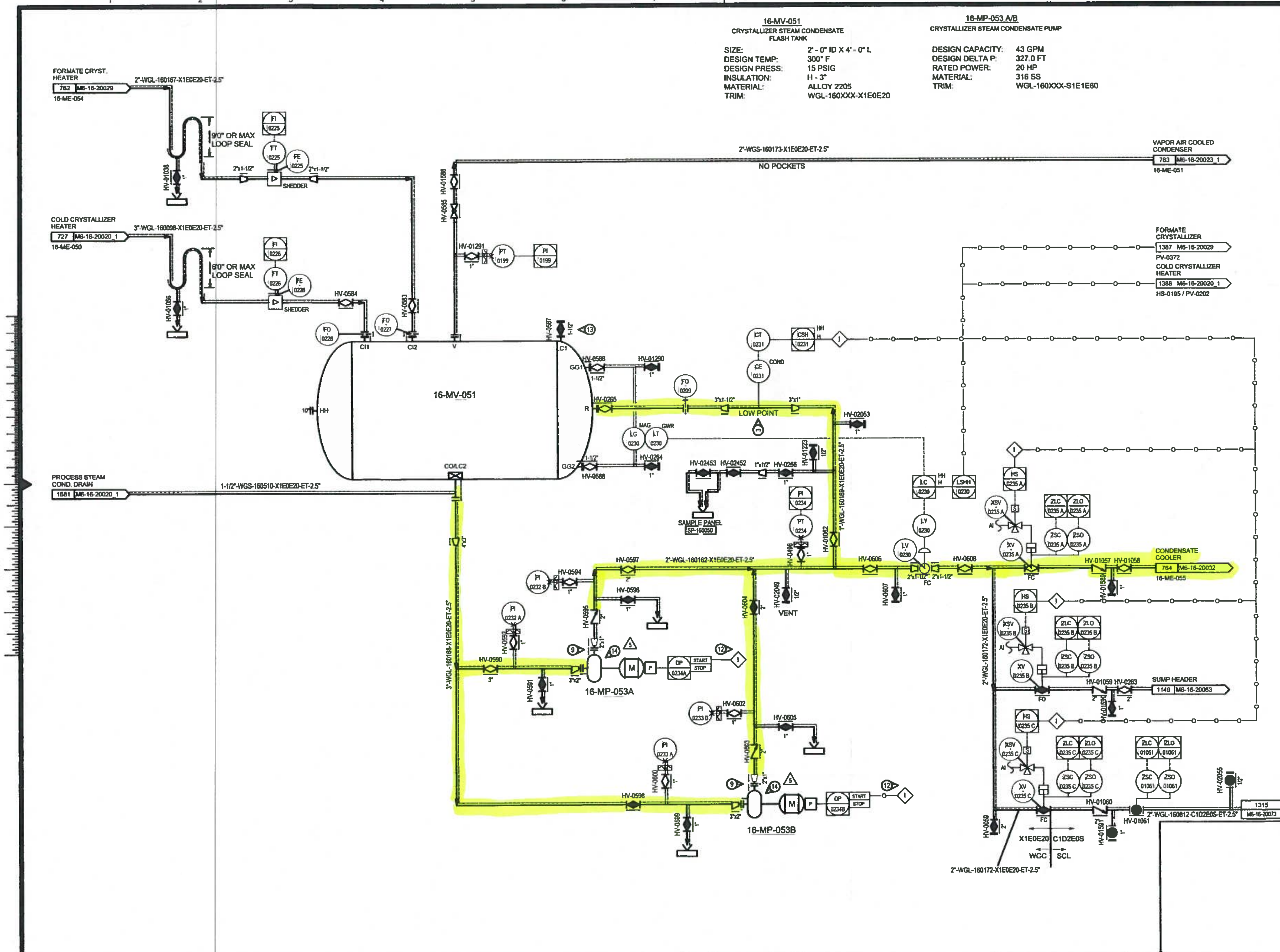

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1	07/23/10	SSK	CAD	REVISED AS NOTED
2	04/22/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0033
3	03/16/12	AAH	TPC	CONFORMING TO CONST. RECORDS
4	03/27/12	TPC	CAD	ISSUED FOR CONST. WITH ECN-0065
5	07/22/14	JDB	JW	ADDED NOTE 14 DO2015-00013

NOTES:

1. NOT USED
2. NOT USED
3. PH AND CONDUCTIVITY PROBES TO BE AT LOW POINT TO REMAIN FULL AT ALL TIMES.
4. NO POCKETS IN LINE.
5. NOT USED
6. NOT USED
7. NOT USED
8. NOT USED
9. INSTALL STARTUP SUCTION SCREEN. REMOVE AFTER INITIAL OPERATION.
10. NOT USED
11. PLUG VALVES ARE PTFE LINED UNLESS OTHERWISE NOTED.
12. SEAL WATER HEADER PRESSURE LOW-LOW FOR 10 SECS TRIPS PUMPS 16-MP-053 A/B
13. VALVE SHALL BE HEAT TRACED UP TO DIAPHRAGM SEAL.
14. SEAL WATER VALVES LOCATED ON P&ID M6-16-20072_1

9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400

date	detailed
Aug 25, 2009	S. KAPHINGST
designed	checked
HPD	C. DEMMEL

Duke Energy. HPD

IGCC GREY WATER TREATMENT

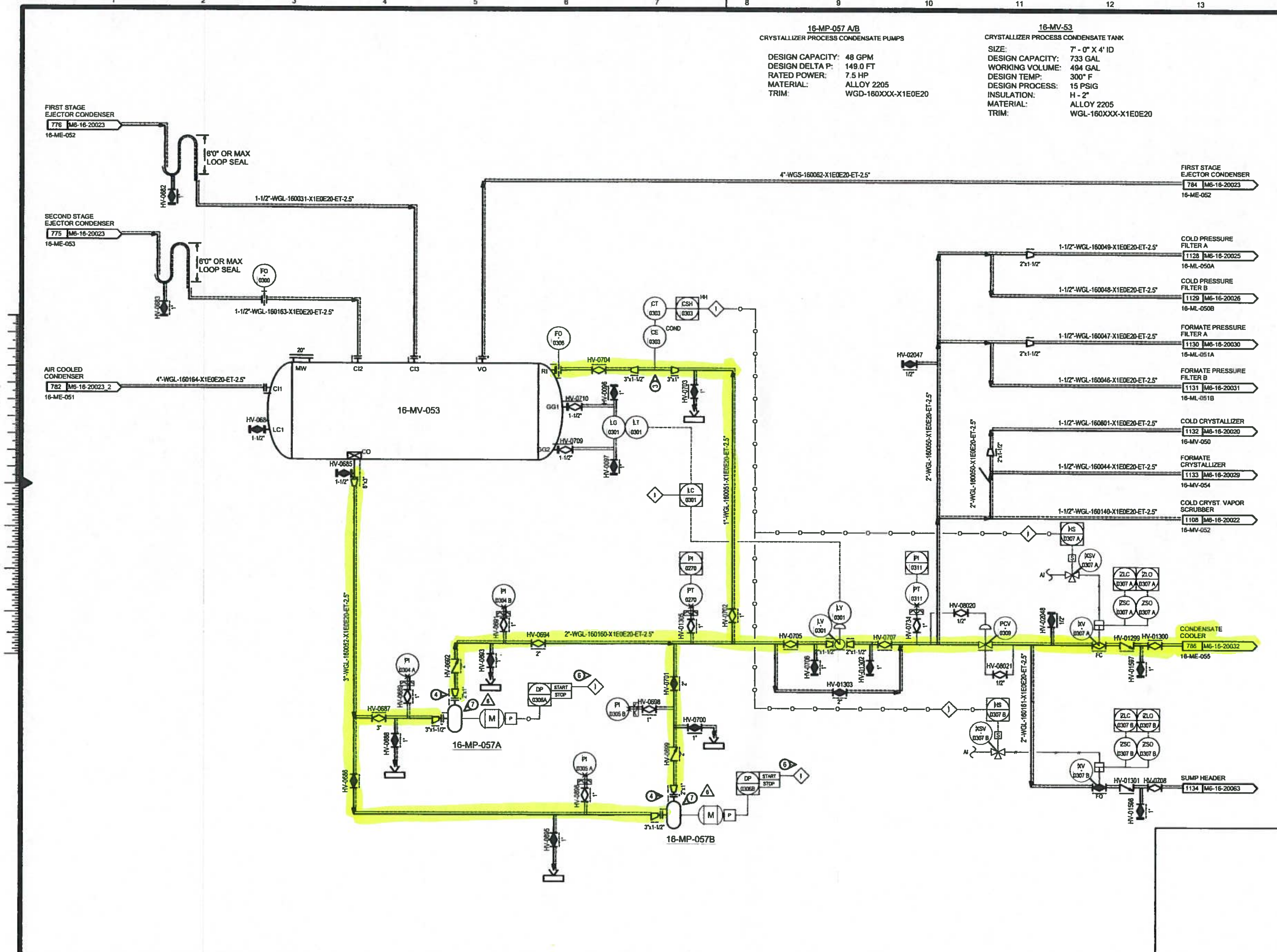
Process & Instrumentation Diagram
CRYSTALLIZER STEAM PROCESS CONDENSATE

project 52240 — contract 5.8321

drawing M6-16-20021 — rev. 5

sheet of sheets

file \Edwardsport\Unit1\52240-M6-16-20021.pid



no.	date	by	chd	description
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1	07/23/10	SSK	CAD	REVISED AS NOTED
2	11/05/10	SSK	CAD	REVISED AS NOTED
3	04/12/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0032
4	04/22/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0033
5	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS
6	07/22/14	JDB	JW	ADDED NOTE 7 DO2015-00013

NOTES:

1. NOT USED
2. NOT USED
3. PH AND CONDUCTIVITY PROBES TO BE LOW POINT TO REMAIN FULL AT ALL TIMES.
4. INSTALL STARTUP SUCTION SCREEN TO BE REMOVED AFTER INITIAL OPERATION.
5. PLUG VALVES ARE PTFE LINE VALVES UNLESS NOTED OTHERWISE.
6. SEAL WATER HEADER PRESSURE LOW-LOW FOR 10 SECS TRIPS PUMPS 16-MP-057A/B
7. SEAL WATER VALVES LOCATED ON P&ID M6-16-20072_1 (6)

9400 WARD PARKWAY
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816-333-9400

date	detailed
Aug 26, 2009	S. KAPHINGST
designed	checked
HPD	C. DEMMEL

Duke Energy. HPD

IGCC GREY WATER TREATMENT

IGCC GREY WATER TREATMENT

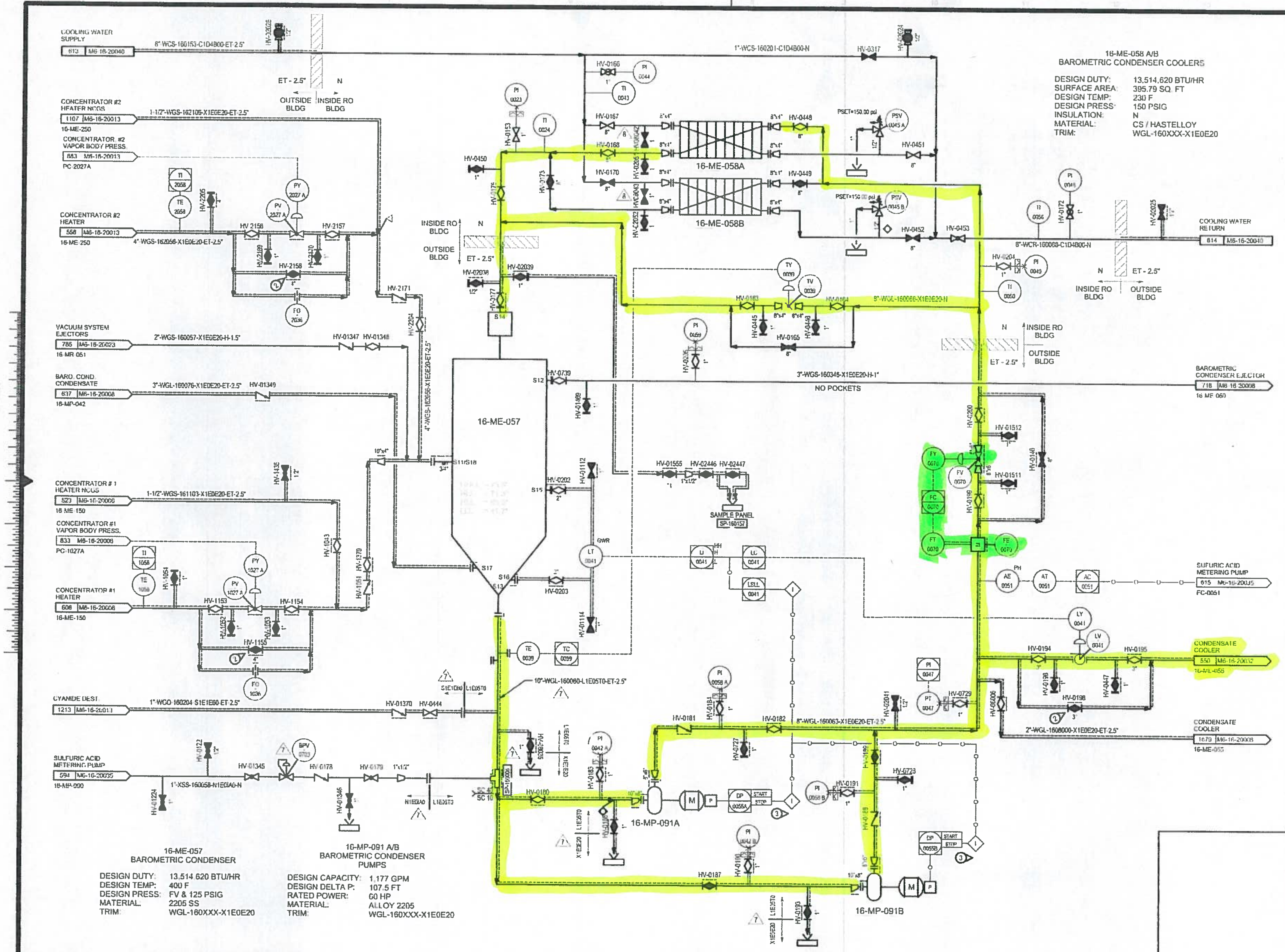
Process & Instrumentation Diagram
CRYSTALLIZER PROCESS
CONDENSATE TANK

project	contract
52240	5.8321

drawing: M6-16-20024 rev. 6

sheet of sheets

file \Edwardsport\Unit1\52240-M6-16-20024.pid



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2	11/05/10	SSK	CAD	REVISED AS NOTED
3	03/29/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0024
4	09/28/11	AAH	TPC	ISSUED FOR DGWC CONST. T/O
5	03/10/12	SSK	TPC	CONFORMING TO CONST. RECORDS
6	09/04/12	SSK	TPC	CONFORMING TO CONST. RECORDS
7	04/17/14	JDB	JC	AS BUILT MOC 2014014-001
8	04/21/15	JDB	JW	RE-NUMBER VALVES DO2015-00027

NOTES:

1. PLUG VALVES ARE PTFE LINED UNLESS NOTED OTHERWISE
2. V-PORT ALLOY 2205 PLUG
3. SEAL WATER HEADER PRESSURE LOW-LOW FOR 10 SECS TRIPS PUMPS 16-MP-091 A/B.

Burns & McDonnell

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816-333-9400

Aug 04, 2009	S. KAPHINGST
B. FOY	C. DEMMEL

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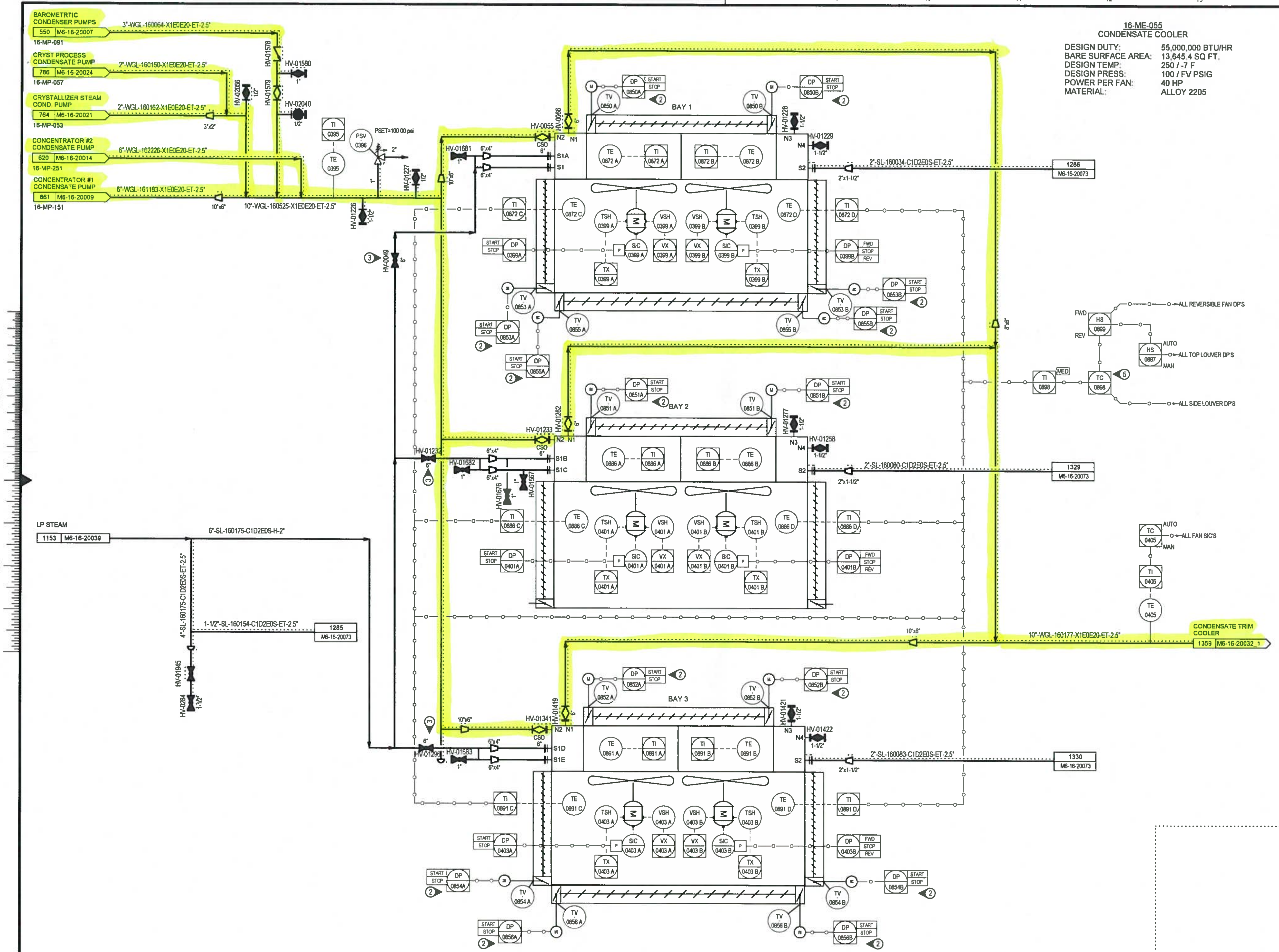
IGCC GREY WATER TREATMENT

Process & Instrumentation Diagram
BAROMETRIC CONDENSER

52240	5.8321

M6-16-20007 — 8



no.	date	by	chd	description
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1	07/23/10	SSK	CAD	REVISED AS NOTED
2	11/05/10	SSK	CAD	REVISED AS NOTED
3	11/30/10	SSK	CAD	ISSUED FOR CONST. WITH ECN-0004
4	04/22/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0033
5	09/28/11	AAH	TPC	ISSUED FOR 0GWC CONST. T/O
6	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS
7	09/04/12	SSK	TPC	CONFORMING TO CONST. RECORDS

NOTES:

1. FORWARD/REVERSE FAN MODE AND SPEED CONTROL BASED ON CONDENSATE TEMPERATURE AND CIRCULATING AIR TEMPERATURE.
2. FAN LOUVER CONTROLS BASED ON CONDENSATE TEMPERATURE AND CIRCULATING AIR TEMP.
3. HIGH POINT.
4. ALL PLUG VALVES ARE PTFE LINED UNLESS NOTED OTHERWISE.
5. AUTO, MANUAL OR CASCADE.

Burns & McDonnell
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400

date	detailed
Aug 27, 2009	J. MESSERSMITH
designed	checked
HPD	C. DEMMEL

Duke Energy HPD

IGCC GREY WATER TREATMENT

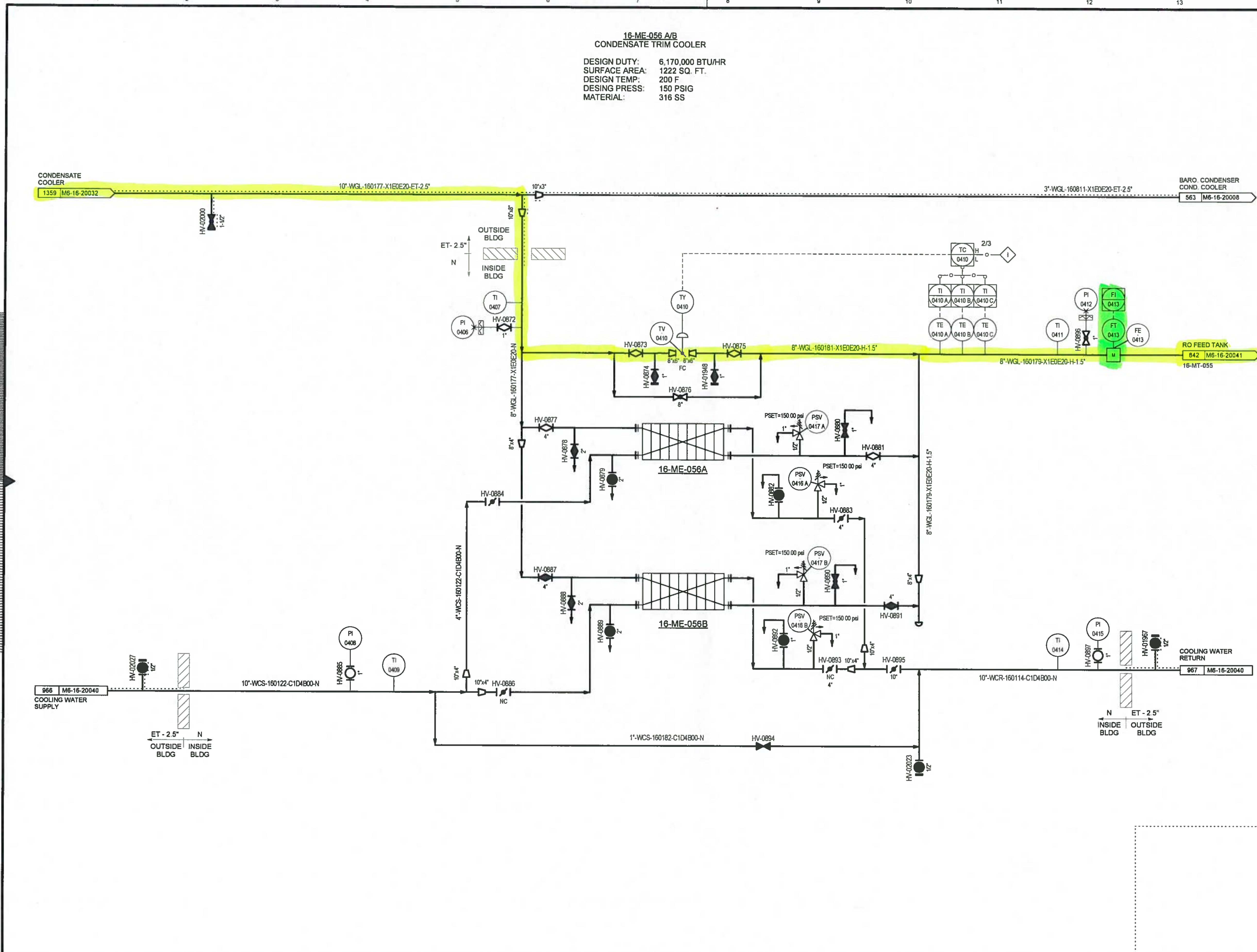
Process & Instrumentation Diagram
CONDENSATE COOLER

project	contract
52240	5.8321

drawing: M6-16-20032 rev. —7

sheet of sheets

file \Edwardsport\Unit1\52240-M6-16-20032.pid



no.	date	by	chd	description
0	06/04/10	SSK	CAD	ISSUED FOR CONTRUCTION
1	07/23/10	SSK	CAD	REVISED AS NOTED
2	11/05/10	SSK	CAD	REVISED AS NOTED
3	05/24/11	SSK	CAD	ISSUED FOR CONST. WITH ECN-0038
4	09/28/11	AAH	TPC	ISSUED FOR 0GWC CONST. T/O
5	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS

NOTES:

1. ALL PLUG VALVES ARE PTFE LINED UNLESS NOTED OTHERWISE.

Burns & McDonnell — 9400 WARD PARKWAY, KANSAS CITY, MO 64114, 816-333-9400

date	detailed
Feb 12, 2010	S. KAPHINGST
designed	**checked**
HPD	C. DEMMEL

Duke Energy HPD

IGCC GREY WATER TREATMENT

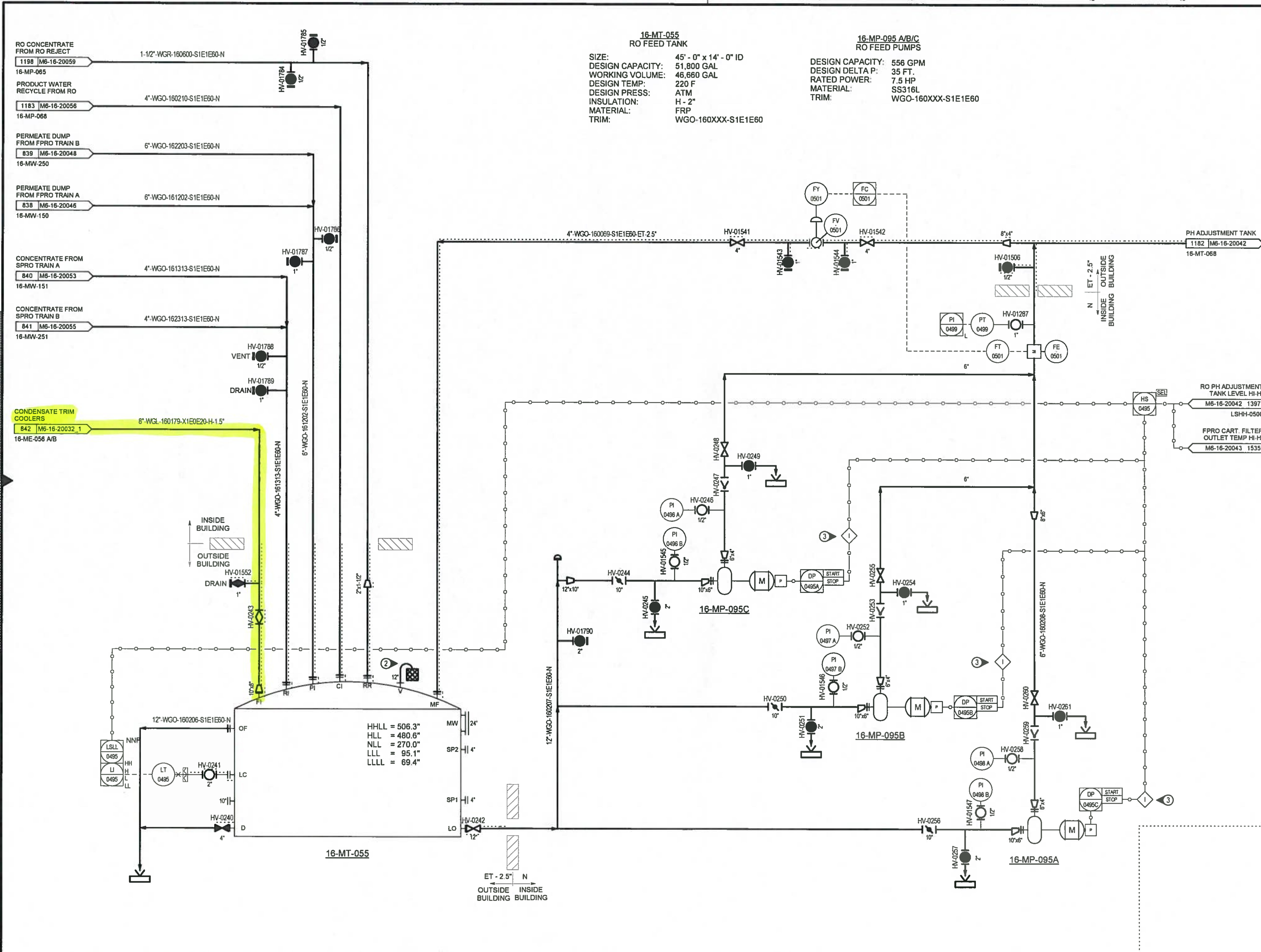
Process & Instrumentation Diagram
CONDENSATE TRIM COOLERS

project	contract
52240	5.8321

drawing: M6-16-20032_1 — rev. 5

sheet / of / sheets

file: \Edwardsport\Unit1\52240-M6-16-20032_1.pid



no.	date	by	chd	description
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1	07/23/10	SSK	CAD	REVISED AS NOTED
2	09/28/11	AAH	TPC	ISSUED FOR 0GWC CONST. T/O
3	10/18/11	AAH	TPC	ISSUED FOR CONST. WITH ECN-0057
4	11/02/11	AAH	TPC	ISSUED FOR CONST. WITH ECN-0060
5	03/16/12	SSK	TPC	CONFORMING TO CONST. RECORDS

NOTES:

1. NOT USED.
2. ROUTE TO SAFE LOCATION.
3. LSLL-0495 TRIPS PUMPS.

Burns & McDonnell
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400

date	detailed
Aug 18, 2009	J. MESSERSMITH
designed	checked
HPD	C.DEMMEL

Duke Energy. HPD

IGCC GREY WATER TREATMENT

Process & Instrumentation Diagram
RO FEED TANK

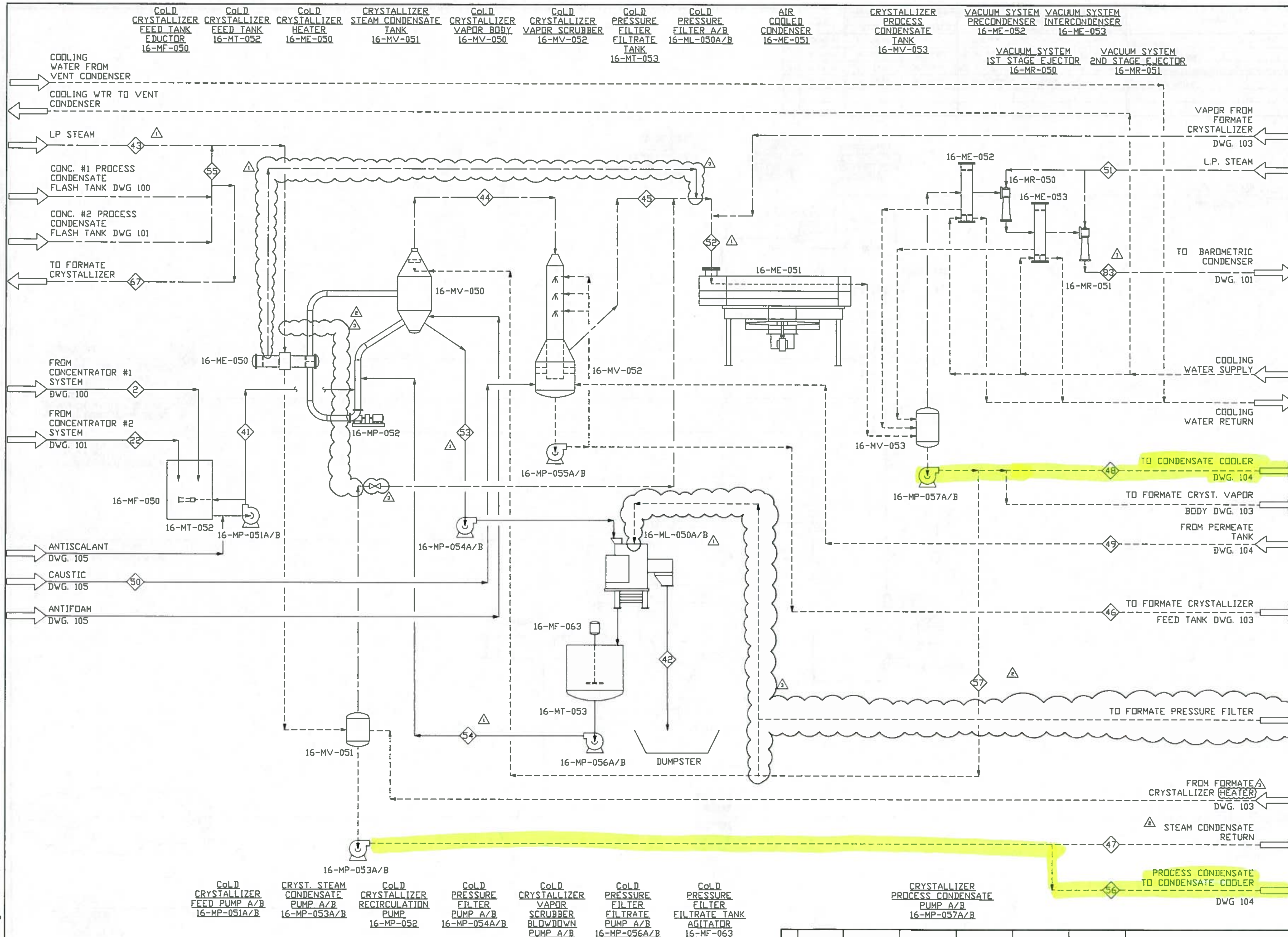
project 52240 contract 5.8321

drawing M6-16-20041 rev. – 5

file \Edwardsport\Unit1\52240-M6-16-20041.pid

Attachment 11

Supplemental Information Submitted by Duke Energy – Additional Grey Water Treatment System Process and Instrumentation Diagrams (January 24, 2017)



GENERAL NOTES

LINE LEGEND

- STEAM / VAPOR
- CONDENSATE
- PROCESS AND SERVICE LINE

REFERENCE DRAWINGS

DWG. NO.	DESCRIPTION

HPD
TEL 1-815-609-2000
PLAINFIELD, IL 60544
AN ISO 9001:2000 FACILITY, CERTIFIED FOR ENGINEERING, PROCUREMENT & PROJECT MANAGEMENT SERVICES

VEOLIA WATER
Solutions & Technologies

SCALE NONE

REV. NO.	ISSUE DATE	DRAWN BY	CHECKED BY	REVIEWED BY	APPROVED BY	APPROVED BY (OPTIONAL)	DESCRIPTION
3	10-11-10	B. Stout	B. Winter	M. A. Edwards	K. Drone	--	REVISED AS NOTED
2	8-16-2010	W. Winter	W. Murray	M. A. Edwards	K. Drone	--	REVISED AS NOTED
1	10-27-09	J. Maples	W. Winter	M. A. Edwards	K. Drone	W. Murray	ADDED EQUIPMENT NUMBERS, AND REVISED AS NOTED
0	9-18-09	W. Winter	R. Fisher	M. A. Edwards	K. Drone	W. Murray	ISSUED FOR DESIGN
E	6-AUG-09	J. Kowal	--	L. Krause	--	--	FIFTH ISSUE

DRAFTING / ENGINEERING

DRAWINGS WITH ALPHA REVISIONS ARE PRELIMINARY AND SHALL NOT BE USED FOR FINAL DESIGN WORK OR FABRICATION.

TITLE
PROCESS FLOW DIAGRAM

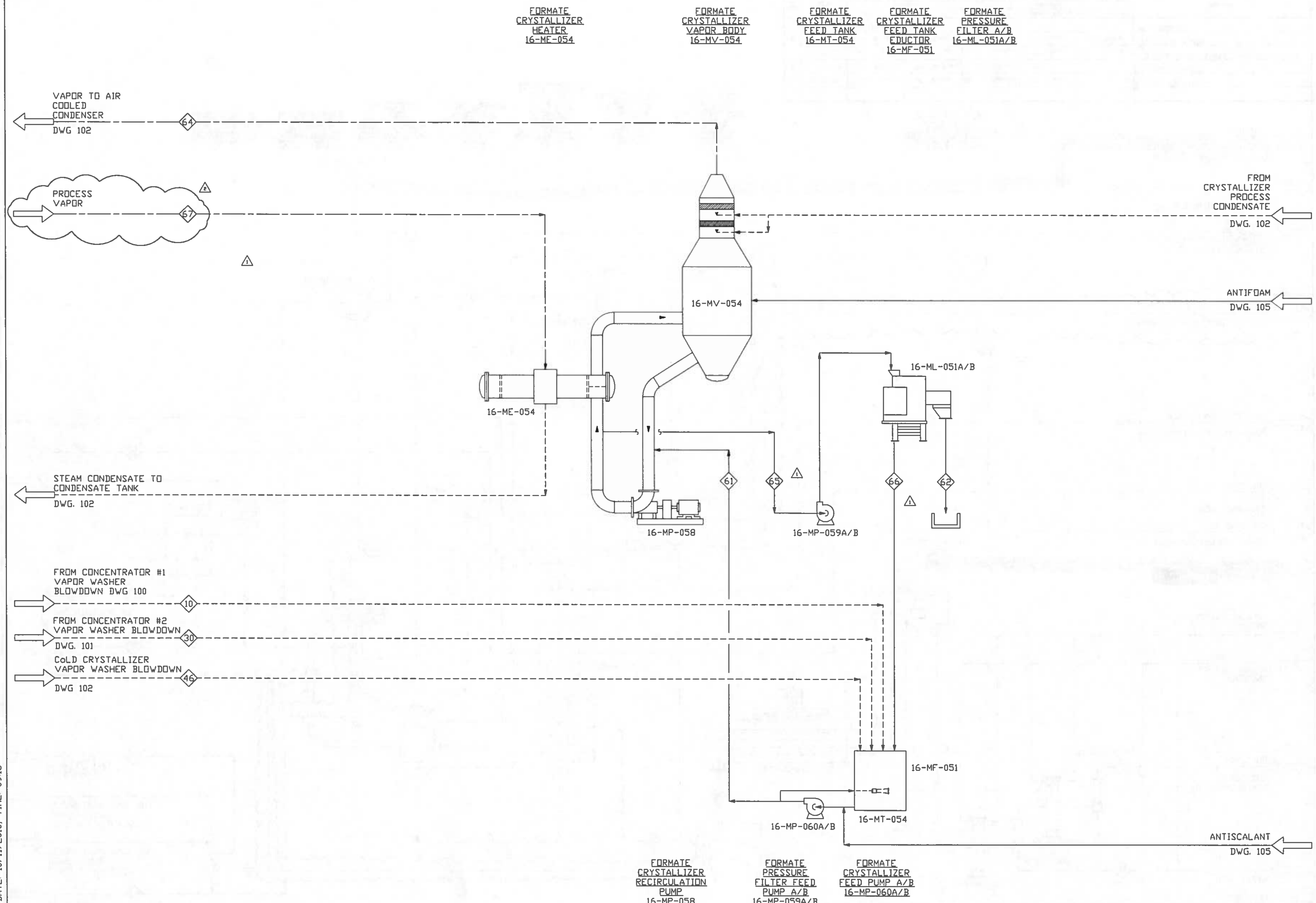
GREY WATER TREATMENT SYSTEM
EDWARDSPORT IGCC FACILITY

FOR: DUKE ENERGY IGCC
EDWARDSPORT, IN

CONTRACT NO. 55019980 DWG. NO. 102 REV 3

FILENAME: 19981023.dwg, DATE: 10/11/2010, TIME: 09:17

GF0010



GENERAL NOTES

LINE LEGEND

- STEAM / VAPOR
- CONDENSATE
- PROCESS AND SERVICE LINE

REFERENCE DRAWINGS

DWG. NO.	DESCRIPTION

HPD

TEL 1-815-609-2000
PLAINFIELD, IL 60544
AN ISO 9001:2000 FACILITY, CERTIFIED FOR ENGINEERING, PROCUREMENT & PROJECT MANAGEMENT SERVICES

VEOLIA WATER
Solutions & Technologies

SCALE: NONE

TITLE: PROCESS FLOW DIAGRAM

GREY WATER TREATMENT SYSTEM
EDWARDSPORT IGCC FACILITY

FOR: DUKE ENERGY IGCC
EDWARDSPORT, IN

CONTRACT NO. 55019980 | DWG. NO. 103 | REV 2

REV. NO.	ISSUE DATE	DRAWN BY	CHECKED BY	REVIEWED BY	APPROVED BY	APPROVED BY (OPTIONAL)	DESCRIPTION
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1	10-27-09	J. Maples	W. Winter	M. A. Edwards	X. Drons	W. Murray	ADDED EQUIPMENT NUMBERS, AND REVISED AS NOTED
0	9-18-09	W. Winter	R. Fisher	M. A. Edwards	X. Drons	W. Murray	ISSUED FOR DESIGN
E	6-AUG-09	J. Horvat	--	L. Krause	--	--	FIFTH ISSUE

DRAFTING: DRAWN BY, CHECKED BY — ENGINEERING: REVIEWED BY, APPROVED BY, APPROVED BY (OPTIONAL)

DRAWINGS WITH ALPHA REVISIONS ARE PRELIMINARY AND SHALL NOT BE USED FOR FINAL DESIGN WORK OR FABRICATION.

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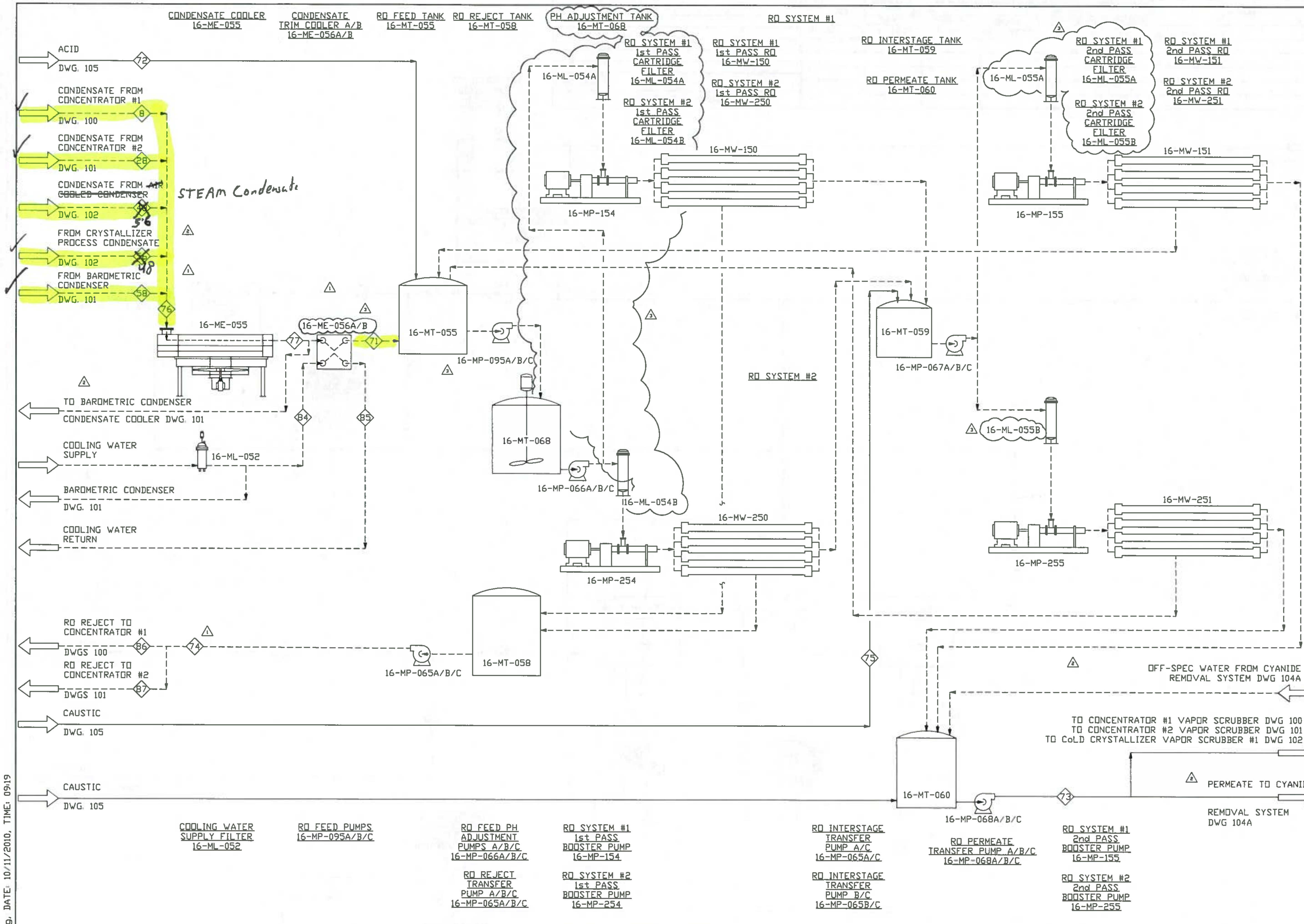
DF001D



GENERAL NOTES

LINE LEGEND

- STEAM / VAPOR
- CONDENSATE
- PROCESS AND SERVICE LINE

REFERENCE DRAWINGS

DWG. NO.	DESCRIPTION

REV. NO.	ISSUE DATE	DRAWN BY	CHECKED BY	REVIEWED BY	APPROVED BY	APPROVED BY (OPTIONAL)	DESCRIPTION
3	10-11-10	B. Stout	W. Winter	M. A. Edwards	X. Drone	--	REVISED AS NOTED
2	8-16-2010	W. Winter	W. Murray	M. A. Edwards	X. Drone	--	REVISED AS NOTED
1	10-27-09	J. Maples	W. Winter	M. A. Edwards	X. Drone	W. Murray	ADDED EQUIPMENT NUMBERS, AND REVISED AS NOTED
0	9-18-09	W. Winter	R. Fisher	M. A. Edwards	X. Drone	W. Murray	ISSUED FOR DESIGN
E	6-AUG-09	J. Kowal	--	L. Krause	--	--	FIFTH ISSUE

DRAFTING / ENGINEERING

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PLAINFIELD, IL. 60544
AN ISO 9001:2000 FACILITY, CERTIFIED FOR ENGINEERING, PROCUREMENT & PROJECT MANAGEMENT SERVICES.

VEOLIA WATER Solutions & Technologies

SCALE: NONE

TITLE: PROCESS FLOW DIAGRAM

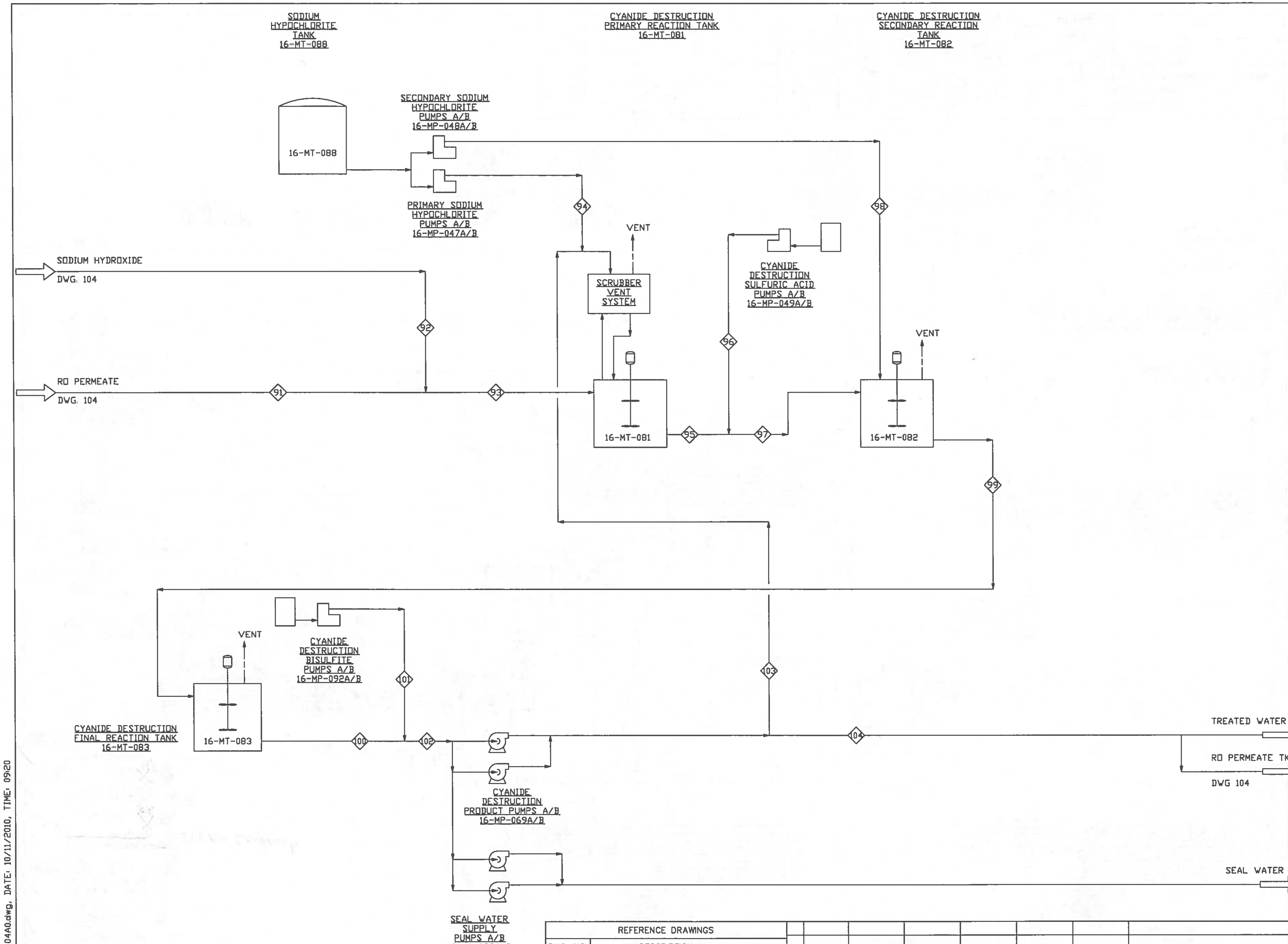
GREY WATER TREATMENT SYSTEM
EDWARDSPORT IGCC FACILITY

FOR: DUKE ENERGY IGCC
EDWARDSPORT, IN

CONTRACT NO. 55019980 | DWG. NO. 104 | REV 3

FILENAME: 19981043.dwg, DATE: 10/11/2010, TIME: 09:19

DF001D



GENERAL NOTES

LINE LEGEND

– – – – – –	STEAM / VAPOR
– – – – – –	CONDENSATE
————	PROCESS AND SERVICE LINE

REFERENCE DRAWINGS	
DWG. NO.	DESCRIPTION
.	

REV. NO.	ISSUE DATE	DRAWN BY	CHECKED BY	REVIEWED BY	APPROVED BY	APPROVED BY (OPTIONAL)	DESCRIPTION
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DRAFTING / ENGINEERING

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PLAINFIELD, IL 60544
AN ISO 9001:2000 FACILITY, CERTIFIED FOR ENGINEERING, PROCUREMENT & PROJECT MANAGEMENT SERVICES
VEOLIA WATER
Solutions & Technologies

SCALE NONE

TITLE

PROCESS FLOW DIAGRAM

GREY WATER TREATMENT SYSTEM
EDWARDSPORT IGCC FACILITY

FOR: DUKE ENERGY IGCC
EDWARDSPORT, IN

CONTRACT NO. 55019980 | DWG. NO. 104A | REV 0

FILENAME: 1998104A0.dwg, DATE: 10/11/2010, TIME: 09:20

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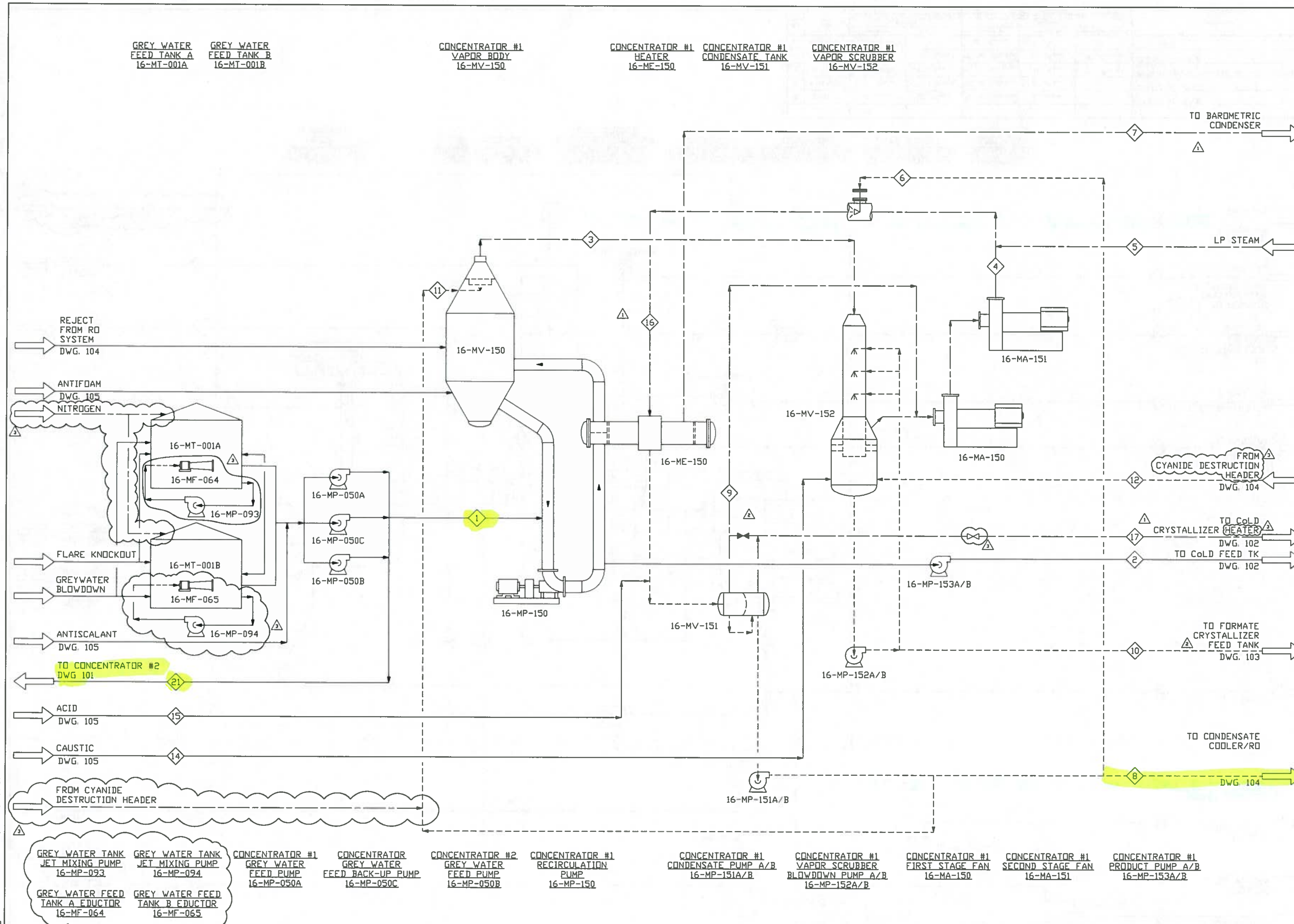

GENERAL NOTES

LINE LEGEND

STEAM / VAPOR
CONDENSATE
PROCESS AND SERVICE LINE

REFERENCE DRAWINGS

DWG. NO.	DESCRIPTION

REV. NO.	ISSUE DATE	DRAWN BY (DRAFTING)	CHECKED BY (DRAFTING)	REVIEWED BY (ENGINEERING)	APPROVED BY (ENGINEERING)	APPROVED BY (OPTIONAL)	DESCRIPTION
3	10-11-10	B. Stout	B. Winter	M. A. Edwards	K. Drane	--	REVISED AS NOTED
2	8-16-2010	W. Winter	W. Murray	M. A. Edwards	K. Drane	--	REVISED AS NOTED
1	10-27-09	J. Maples	W. Winter	M. A. Edwards	K. Drane	W. Murray	ADDED EQUIPMENT NUMBERS, AND REVISED AS NOTED
0	9-18-09	W. Winter	R. Fisher	M. A. Edwards	K. Drane	W. Murray	ISSUE FOR DESIGN
E	6-AUG-09	J. Peterson	--	L. Krause	--	--	FIFTH ISSUE

DRAWINGS WITH ALPHA REVISIONS ARE PRELIMINARY AND SHALL NOT BE USED FOR FINAL DESIGN WORK OR FABRICATION.

HPD
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VEOLIA WATER
Solutions & Technologies

SCALE: NONE

TITLE: PROCESS FLOW DIAGRAM

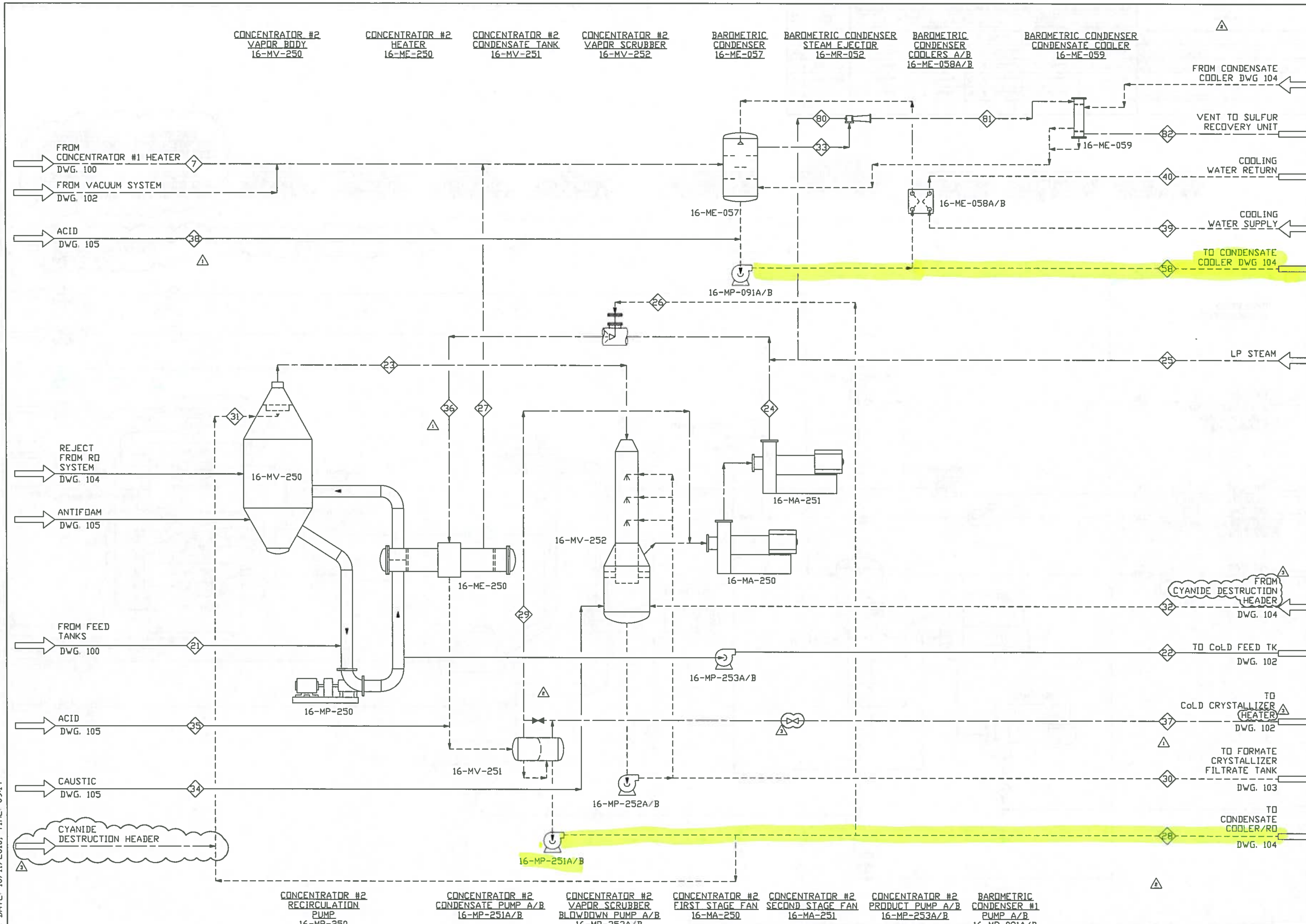
GREY WATER TREATMENT SYSTEM
EDWARDSPORT IGCC FACILITY

FOR: DUKE ENERGY IGCC
EDWARDSPORT, IN

CONTRACT NO. 55019980 | DWG. NO. 100 | REV 3

FILENAME: 19981003.dwg, DATE: 10/11/2010, TIME: 09:10

DF001D



GENERAL NOTES

LINE LEGEND

STEAM / VAPOR
CONDENSATE
PROCESS AND SERVICE LINE

REFERENCE DRAWINGS

DWG. NO.	DESCRIPTION

HPD

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SCALE: NONE

TITLE: PROCESS FLOW DIAGRAM

GREY WATER TREATMENT SYSTEM
EDWARDSPORT IGCC FACILITY

FOR: DUKE ENERGY IGCC
EDWARDSPORT, IN

CONTRACT NO. 55019980 | DWG. NO. 101 | REV 3

REV. NO.	ISSUE DATE	DRAWN BY (DRAFTING)	CHECKED BY (DRAFTING)	REVIEWED BY (ENGINEERING)	APPROVED BY (ENGINEERING)	APPROVED BY (OPTIONAL) (ENGINEERING)	DESCRIPTION
3	10-11-10	B. Stout	B. Winter	M. A. Edwards	X. Drone	--	REVISED AS NOTED
2	8-16-2010	W. Winter	W. Murray	M. A. Edwards	X. Drone	--	REVISED AS NOTED
1	10-27-09	J. Maples	W. Winter	M. A. Edwards	X. Drone	W. Murray	ADDED EQUIPMENT NUMBERS, AND REVISED AS NOTED
0	9-18-09	W. Winter	R. Fisher	M. A. Edwards	X. Drone	W. Murray	ISSUED FOR DESIGN
E	6-AUG-09	J. Kowal	--	L. Krause	--	--	FIFTH ISSUE

DRAWINGS WITH ALPHA REVISIONS ARE PRELIMINARY AND SHALL NOT BE USED FOR FINAL DESIGN WORK OR FABRICATION.

FILENAME: 19981013.dwg, DATE: 10/11/2010, TIME: 0914

DF001D

Attachment 12

Duke Energy Calculations for Alternative Limits at Edwardsport IGCC Station

From:	Ramach, Sean
To:	Jordan, Ronald
Subject:	FW: Duke Energy Edwardsport IGCC Station (NPDES Permit IN0002780); Information requested for FDFV application
Date:	Wednesday, June 28, 2017 1:51:05 PM
Attachments:	Method of Calculation of Duke Energy''s Proposed Alternative BAT Effluent....docx IGCC Limits Calculated Using Data from Edwardsport proposed Appendix X v....pdf Appendix B Delta Log Normal Procedure.pdf

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Cheers,

Sean Ramach

Environmental Scientist | P:202-564-2865 | ramach.sean@epa.gov
U.S. EPA, OWM, WPD, Industrial Branch | 1200 Pennsylvania Ave., 4203M | Washington, DC 20460

For packages or overnight delivery, please mail to: 1201 Constitution Ave., 4203M, Washington DC 20004

From: Gardner, Nicole [mailto:ngardner@idem.IN.gov]
Sent: Wednesday, June 28, 2017 1:41 PM
To: Ramach, Sean <Ramach.Sean@epa.gov>
Subject: FW: Duke Energy Edwardsport IGCC Station (NPDES Permit IN0002780); Information requested for FDFV application

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From: Gardner, Nicole
Sent: Wednesday, July 20, 2016 8:33 AM
To: Hamblin, Richard <rhamblin@idem.IN.gov>
Subject: FW: Duke Energy Edwardsport IGCC Station (NPDES Permit IN0002780); Information requested for FDFV application

FYI

From: RIGNEY, STAN
Sent: Wednesday, July 20, 2016 7:06 AM
To: ELLIOTT, JOHN; Novak, Paul
Cc: Gardner, Nicole
Subject: FW: Duke Energy Edwardsport IGCC Station (NPDES Permit IN0002780); Information requested for FDFV application

Here is everything Duke sent me related to their alternate limits development approach. I haven't had a chance to review yet but plan to do so before the internal meeting on the 28th.

From: Coyle, Pat [mailto:Pat.Coyle@duke-energy.com]
Sent: Monday, July 18, 2016 4:49 PM
To: RIGNEY, STAN; Hamblin, Richard
Cc: Larry Kane (LKane@bgdlegal.com); Ezell, Julie L; Peacock, Mark D; Woodcox, Garth W; Craig, Nathan D; Fisher, Sheryl L
Subject: Duke Energy Edwardsport IGCC Station (NPDES Permit IN0002780); Information requested for FDFV application

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Stan - As requested, attached is documentation from our consultant (AECOM) in support of the alternative BAT limits proposed for the Edwardsport IGCC Station in Duke Energy's Fundamentally Different Factors Variance application.

The first attachment (in Word format) is an explanation of how the alternative limits were calculated using EPA's Modified Delta Log Normal Statistical Procedures. The second attachment (in PDF format) shows the actual calculations, with explanatory notes. The third attachment (in PDF format) is a copy of the EPA technical document pages that explain the "Modified" Delta Log Normal Distribution as it applies to the rule.

Please call if any questions about this information.

Pat Coyle
Duke Energy – Environmental Services
139 E. Fourth St., EM740, Cincinnati, OH 45202-4003
Office: 513-287-2268 / Cell: 513-509-0040

From: RIGNEY, STAN [mailto:SRIGNEY@idem.IN.gov]
Sent: Wednesday, June 29, 2016 11:44 AM
To: Coyle, Pat
Subject: information request

Pat, as I am continuing my review and evaluation of the FDF request I would like to request the following:

On page 37 of your FDF request, for the calculation of the interim limitation for Arsenic of 8 ug/l, this value was determined based upon a data set where the data was all below the existing BAT requirement of 4.0 ppb. Could you provide the calculations on how this value was determined.

Your request for alternative limitations for both Mercury and TDS were calculated using EPA's statistical methodology. IDEM would like to see the calculations used to calculate the interim limitations for these two parameters.

Stan Rigney
Senior Environmental Engineer
Industrial NPDES Permits Section
Indiana Department of Environmental Management
Office of Water Quality, Mail Code 65-42
100 N. Senate Ave.
Indianapolis, IN 46204-2251
srigney@idem.IN.gov
Phone: 317/232-8709
Fax: 317/232-8637

AECOM

Calculation Methods for Derivation of Duke Energy's Alternative Effluent Limitations

7/18/16

This memorandum provides a brief explanation of the methods by which Duke Energy's proposed alternative BAT effluent limitations for Gasification Wastewater discharged from the Edwardsport IGCC facility were calculated for inclusion in its application for a Fundamentally Different Factor Variance that is now pending with U.S. EPA and the Indiana Department of Environmental Management.

I. Alternative BAT Effluent Limitations for Gasification Wastewater at the Edwardsport IGCC Facility

The proposed alternative BAT effluent limits are:

Pollutant	Daily Maximum	30-day Average
Arsenic, total (ug/L)	8.0	--
Mercury, total (ug/L)	30	12.4
TDS (mg/L)	78	36
Selenium, total (ug/L)	453	227

II. Calculation Methods for Deriving the Alternative BAT Effluent Limitations

Mercury and TDS: the alternative effluent limitations (both the daily maximum and monthly average limits) are calculated from effluent data obtained from the grey water treatment system at Edwardsport IGCC using EPA's statistical methodology. This calculation process is termed the "Modified Delta Log-normal Distribution", and is discussed in Appendix B to the Final Technical Development document (Docket ID EPA-HQ-OW-2009-0819-6432). For the Steam Electric ELGs, EPA derived the monthly average limits based on a random generation of multiple "monthly averages", each consisting of a set of four individual sample concentration values chosen at random from the available data set for each parameter and waste stream. In the response to comments for the final rule, EPA stated that four samples were necessary to calculate the variability of the monthly averages. AECOM believes that such a random approach on the Edwardsport data set would likely eliminate valid data indicative of true variability of the system over set periods of time. In addition, the EPA random generation method cannot be exactly reproduced by a third party, since EPA did not divulge exactly which samples were randomly selected, nor how many sets of four-sample monthly averages were generated for use in their calculations.

Therefore, for the Edwardsport data, AECOM generated the monthly averages by taking the averages of four successive samples at a time in order of the date sampled. This had the advantage of grouping four samples taken within a set time period, even if they were not always collected within the same month. For the mercury calculations on the Edwardsport data, there were only three samples remaining for the last monthly average, AECOM therefore reused the previous sample (2.40 ng/L, dated 10/6/2015) by including it also in the last monthly average, so that each monthly average consisted of four samples. In addition, AECOM determined that one of the TDS results, specifically the value of 222 mg/L, was an outlier that would inordinately impact the final limits, biasing them high. This sample result was not used. A copy of the calculation sheet with notes is attached to this memorandum.

Selenium: no change is proposed from the BAT effluent limitations in the steam Electric ELGs.

Modified protocol proposal for setting effluent limits for arsenic. Arsenic was not detected in Gasification Wastewater sampling from the Polk facility used by EPA to generate the arsenic limits. Similarly, except for one apparent outlier, arsenic (total) has not been detected in Edwardsport IGCC's Treated grey water effluent.

Because arsenic had not been detected in any of the IGCC wastewater analyzed for the Steam Electric ELGs, EPA set the arsenic daily maximum limit at the reported quantitation limit of 4.0 ug/L without using their calculation method. The EPA contract laboratory had determined this value to be the limit of quantitation for IGCC and other Steam Electric wastewaters for arsenic. However, Duke Energy proposes that use of the quantitation limit as the regulatory limitation in this circumstance is unduly restrictive since scenarios are possible in which all sample data were below the quantitation limit but a calculated limit under the statistical model methodology would be higher than the quantitation limit. In addition, normal analytical variability could cause more frequent violations for any limit set right at the quantitation level.

To illustrate the alternate approach proposed by Duke Energy, AECOM conducted a calculation using a series of four hypothetical values, all below the quantitation limit for arsenic (1, 2, 3, and 3.5 ug/L). AECOM performed the EPA's delta-lognormal limits calculation for the daily maximum limit on these values as if it were a real data set (see attachment). The results calculated from this hypothetical dataset produced a daily maximum limit of 8 ug/L, which is the value proposed by Duke Energy as the alternative effluent limit for arsenic. Like EPA, AECOM also did not attempt to calculate a monthly average limit, since no true quantitative results were available.

AECOM Calculations of the Arsenic, Mercury, and TDS Limits Using Effluent Data from the Edwardsport Facility

Sample	Plant Name	Data Source	Pollutant	Date	Unit	Original Indicator	Original Daily Concentration	Ln original conc	Monthly Average	ln monthly average
Arsenic Limits based on Four Hypothetical Samples, all Valued Below EPA Reporting Limit (See Explanation sheet)										
1	Plant X	Hypothetical effluent	Arsenic	XX	ug/L	NA	1	0		
2	Plant X	Hypothetical effluent	Arsenic	XX	ug/L	NA	2	0.693147181		
3	Plant X	Hypothetical effluent	Arsenic	XX	ug/L	NA	3	1.098612289		
4	Plant X	Hypothetical effluent	Arsenic	XX	ug/L	NA	3.5	1.252762968		
								0.761130609	Ln averages	
								0.313179271	Var (sigma2)	
								0.559624223	Std Dev (sigma)	
Arsenic Limit Based on Values Below EPA Quantitation Limit of 4.0 (ug/L)						LTA	2.5036		2.5036	
						DMVf1	3.142744009	MAVf1	NA	
						Daily Max (DM)	7.868	Or 8.0 ug/L when rounded up as per EPA protocol.		
		Mercury Limit Calculations Using Edwardsport Data								
effluent	Edwardsport	Self-sampled	Mercury	7/22/2013	ng/L	D	2.08	0.732367894		
effluent	Edwardsport	Self-sampled	Mercury	8/8/2013	ng/L	D	9.58	2.259677592		
effluent	Edwardsport	Self-sampled	Mercury	10/3/2013	ng/L	D	2.53	0.928219303		
effluent	Edwardsport	Self-sampled	Mercury	9/8/2015	ng/L	D	12.8	2.549445171	6.7475	1.909172066
effluent	Edwardsport	Self-sampled	Mercury	9/10/2015	ng/L	D	5.25	1.658228077		
effluent	Edwardsport	Self-sampled	Mercury	9/15/2015	ng/L	D	10.3	2.332143895		
effluent	Edwardsport	Self-sampled	Mercury	9/17/2015	ng/L	D	6.55	1.87946505		
effluent	Edwardsport	Self-sampled	Mercury	9/22/2015	ng/L	D	10.8	2.379546134	8.225	2.107178297
effluent	Edwardsport	Self-sampled	Mercury	9/24/2015	ng/L	D	11.5	2.442347035		
effluent	Edwardsport	Self-sampled	Mercury	9/29/2015	ng/L	D	6.40	1.85629799		
effluent	Edwardsport	Self-sampled	Mercury	10/1/2015	ng/L	D	3.92	1.366091654		
effluent	Edwardsport	Self-sampled	Mercury	10/6/2015	ng/L	D	2.40	0.875468737	6.055	1.800884377
effluent	Edwardsport	Self-sampled	Mercury	10/8/2015	ng/L	D	5.79	1.756132292		
effluent	Edwardsport	Self-sampled	Mercury	10/13/2015	ng/L	D	3.05	1.115141591		
effluent	Edwardsport	Self-sampled	Mercury	10/15/2015	ng/L	D	0.877	-0.131248287	3.02925	1.108315064
								1.599954942	Ln averages	1.731387451
								0.598392496	Var (sigma2)	0.18862505
								0.773558334	Std Dev (sigma)	0.434309855
	Mercury Limits Based on Edwardsport Data (ng/L)					LTA	6.6802		6.6802	
						DMVf1	4.482139217	MAVf1	1.855131601	
						Daily Max	29.9	Monthly Average	12.4	
		TDS Limit Calculations Using Edwardsport Data								
effluent	Edwardsport	Self-sampled	TDS	9/8/2015	mg/L	D	20	2.995732274		
effluent	Edwardsport	Self-sampled	TDS	9/10/2015	mg/L	D	40	3.688879454		
effluent	Edwardsport	Self-sampled	TDS	9/15/2015	mg/L	ND	10	2.302585093		
effluent	Edwardsport	Self-sampled	TDS	9/17/2015	mg/L	D	20	2.995732274	23	3.113515309
effluent	Edwardsport	Self-sampled	TDS	9/22/2015	mg/L	D	10	2.302585093		
effluent	Edwardsport	Self-sampled	TDS	9/24/2015	mg/L	ND	10	2.302585093		
effluent	Edwardsport	Self-sampled	TDS	9/29/2015	mg/L	D	32	3.465735903		
effluent	Edwardsport	Self-sampled	TDS	10/1/2015	mg/L	D	20	2.995732274	18	2.890371758
effluent	Edwardsport	Self-sampled	TDS	10/6/2015	mg/L	D	20	2.995732274		
effluent	Edwardsport	Self-sampled	TDS	10/8/2015	mg/L	D	14	2.63905733		
effluent	Edwardsport	Self-sampled	TDS	10/13/2015	mg/L	D	"222"	Outlier, not used. Likely treatment upset or lab error.		
effluent	Edwardsport	Self-sampled	TDS	10/15/2015	mg/L	D	60	4.094344562	31	3.444682494
								2.979881966	Ln averages	3.149523187
								0.347411789	Var (sigma2)	0.077787523
								0.589416482	Std Dev (sigma)	0.278904147
	TDS Limits Based on Edwardsport Data (mg/L)					LTA	23.4199		23.4199	
						DMVf1	3.311088019	MAVf1	1.519694062	
						Daily Max	77.5	Monthly Average	35.6	
For further details, see Expanation sheet.										

Explanations for Calculations of Edwardsport Data

General Assumptions:	EPA practice for this ELG was to round up limits to nearest whole unit of measure for the final Daily Maximum (DM and Monthly Average (MA) limits. AECOM identifed two results as outliers: one arsenic at 15 ug/L, and one TDS at 222 mg/L. AECOM did not use these data points, in each case these would have caused the limits to be much higher. For monthly averages developed for the final SE Rule, EPA used multiple averages of four samples randomly generated from the data set. The EPA MA limits could not be exactly reproduced because EPA did not provide the specific MA's generated by their random process, nor did they reveal how many MAs were generated. EPA most likely was forced to use the same individual samples more than once in their random drawing to produce muliple monthly averages, each consisting of four sample results. Here, AECOM calculated the monthly averages using four successive samples. For mercury, there were only three samples left for the last monthly average. (For TDS, one of the four was an outlier.) AECOM calculated the last monthly average for mercury using the last four samples, reusing one previous sample, to conform to EPA procedures.
AECOM Determination of arsenic limit:	EPA had their laboratory determine quantitation limits for Steam Electric wastewater. The EPA lab determined arsenic could be quantitated down to 4.0 ug/L in the SE samples. In the SE ELG, EPA acknowledged that unless at least two samples were detected, no variability could be calculated, so that no limits could be developed by the usual proedures. For the IGCC limits, EPA had only four sample results from a single facility; all were ND at the 4.0 ug/L quantitation limit (QL), limits could not be calculated using the EPA procedure. Therefore, EPA simply set a daily maximum limit for arsenic at the 4.0 ug/L QL. EPA did not set a monthly average limit. The Edwardsport effluent data consisted of 14 non-detected samples with varying reporting limits. There was one detection at 15 ug/L that AECOM assumed was an outlier. AECOM believes that setting a limit at the estimated QL of the method is not viable, because there can be normal variability in arsenic concentrations below the quantitation limit. For example, if the arsenic was frequently present at values close to (but under) the 4.0 ug/L QL, random variability could occassionally cause a slight detection and violation. To demonstrate, AECOM generated four hypothetical samples with concentrations at various levels under the 4.0 ug/L QL. These samples were used in the EPA daily maximum calculation method. This hypothetical arsenic calculation shows it is easily possible to generate a daily maximum limit of 8.0 ug/L even when all four results are below the 4.0 QL limit. AECOM therefore proposed that the arsenic daily maximum limit be set at 8.0 rather than 4.0 ug/L. Just like EPA, AECOM did not attempt to calculate a monthly average arsenic limit, since there really were no quantitative results available.

Appendix B

MODIFIED DELTA-LOG NORMAL DISTRIBUTION

Appendix B: Modified Delta-Lognormal Distribution

Appendix B describes the modified delta-lognormal distribution and the estimation of the plant-specific long-term averages and plant-specific variability factors used to calculate the limitations and standards. This appendix provides the statistical methodology that was used to obtain the results presented in Section 13 of the Technical Development Document. For simplicity, in the remainder of this appendix, references to "limitations" include "standards."

The term "detected" in this document refers to analytical results measured and reported above the sample-specific quantitation limit. Thus, the term "non-detected" refers to values that are below the method detection limit (MDL) and those measured by the laboratory as being between the MDL and the quantitation limit (QL).

Effluent concentrations are often autocorrelated such that concentrations in samples collected close together in time are more similar than concentrations from samples collected farther apart in time. When the data are deemed to be positively autocorrelated, the variance estimate from samples collected on successive days will be less than the variance of the long-term concentration series, and thus the variance estimates from the sampled days should be adjusted for the correlation when estimating the variance for the long-term series. Equations (17) and (34) below include autocorrelation adjustments to the basic equations for calculating the limits using the modified-delta-lognormal distribution.[183] See Section 13 of the Technical Development Document for a discussion of using autocorrelation in calculating the limits.

B.1 Basic Overview of the Modified Delta-Lognormal Distribution

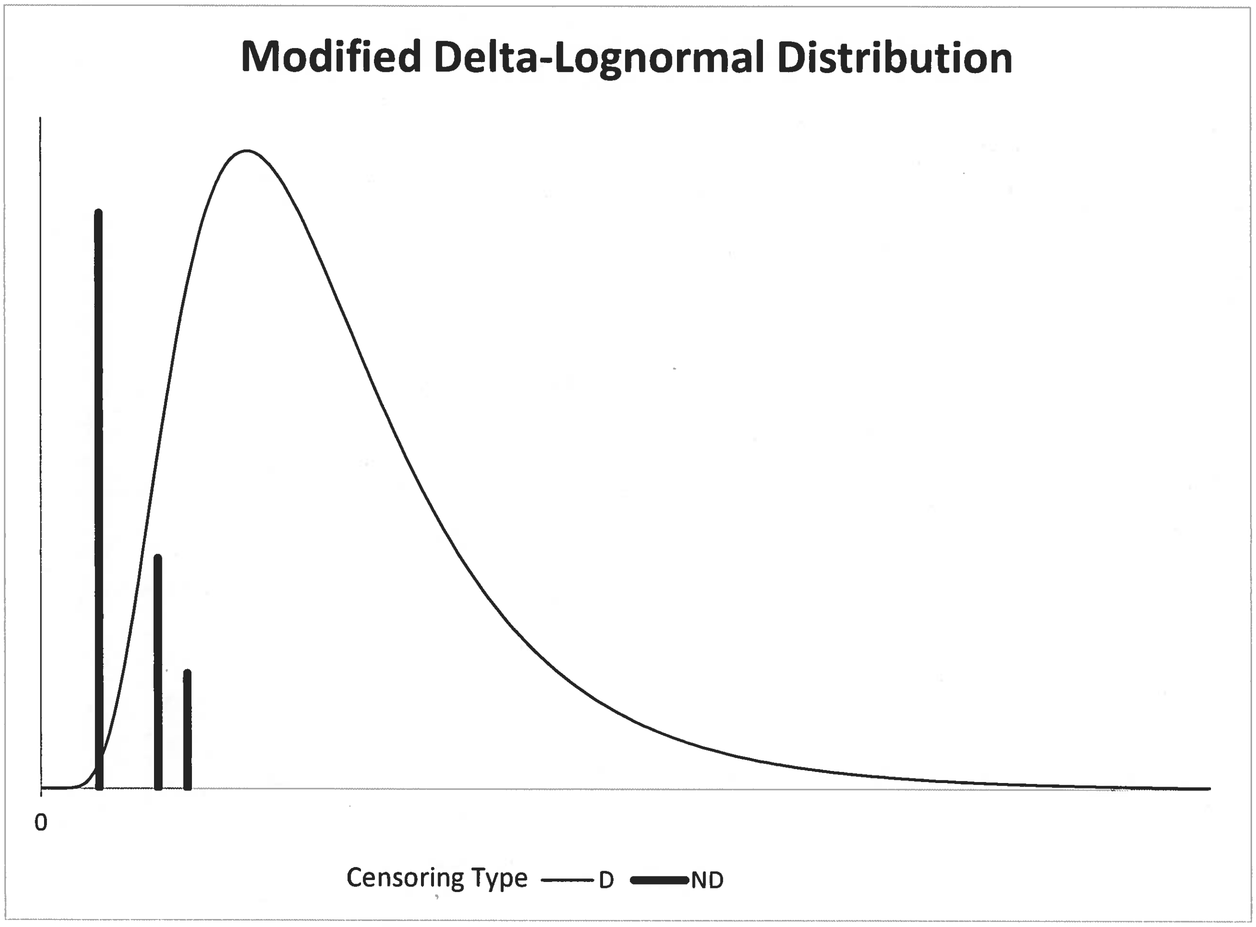
EPA selected the modified delta-lognormal distribution to model pollutant effluent concentrations from the steam electric power generating industry in developing the long-term averages (LTA) and variability factors. A typical effluent data set from EPA sampling, Clean Water Act (CWA) 308 sampling, or from a plant's self-monitoring consists of a mixture of measured (detected) and non-detected values. The modified delta-lognormal distribution is appropriate for such datasets because it models the data as a mixture of detected measurements that follow a lognormal distribution and non-detect measurements that occur with a certain probability. The model also allows for the possibility that non-detected measurements occur at multiple sample-specific detection limits. Because the data appeared to fit the modified delta-lognormal model reasonably well, EPA has determined that this model is appropriate for these data.

The modified delta-lognormal distribution is a modification of the 'delta distribution' originally developed by Aitchison and Brown (1963). While this distribution was originally developed to model economic data, other researchers have shown the application to environmental data [Owen and DeRouen, 1980]. The resulting mixed distributional model, which combines a continuous density portion with a discrete-valued spike at zero, is also known as the delta-lognormal distribution. The delta in the name refers to the proportion of the overall

[183] In response to comments on the proposed rule, EPA reviewed the procedures used to adjust for correlation for the proposed rule and used in previous effluent guidelines. The equations for this final rule were previously used for the Iron and Steel effluent guidelines except those guidelines used equation (19) instead of equation (18). Since the samples for this rule were not collected on sequential days, equation (18) is used.

distribution contained in the discrete distributional spike at zero (i.e., the proportion of zero amounts). The remaining non-zero amounts are grouped together and fit to a lognormal distribution.

EPA modified this delta-lognormal distribution to incorporate multiple detection limits. In the modification of the delta portion, the single spike located at zero is replaced by a discrete distribution made up of multiple spikes. Each spike in this modification is associated with a distinct sample-specific detection limit associated with non-detected (ND) measurements in the database. A lognormal density is used to represent the set of detected (D) values. This modification of the delta-lognormal distribution is illustrated in the figure below.



The following two sections describe the delta and lognormal portions of the modified delta-lognormal distribution in further detail.

B.2 Continuous and Discrete Portions of the Modified Delta-Lognormal Distribution

In the discrete portion of the modified delta-lognormal distribution, the non-detected values correspond to the k reported sample-specific detection limits. In the model, δ represents the proportion of non-detected values and is the sum of δ_i, i=1,…,k, which represents the proportion of non-detected values associated with the i^{th} distinct detection limit. By letting D_i

equal the value of the i^{th} smallest distinct detection limit in the dataset and letting the random variable X_D represent a randomly chosen non-detected measurement, the cumulative distribution function of the discrete portion of the modified delta-lognormal model can be mathematically expressed as:

$$Pr(X_D \leq c) = \frac{1}{\delta} \sum_{i:D_i \leq c} \delta_i \,, c > 0 \tag{1}$$

The mean and variance of this discrete distribution can be calculated using the following formulas:

$$E(X_D) = \frac{1}{\delta} \sum_{i=1}^{k} \delta_i \, D_i \tag{2}$$

$$Var(X_D) = \frac{1}{\delta} \sum_{i=1}^{k} \delta_i (D_i - E(X_D))^2 \tag{3}$$

EPA used the continuous, lognormal portion of the modified delta-lognormal distribution to model the detected measurements. The cumulative probability distribution of the continuous portion of the modified delta-lognormal distribution can be mathematically expressed as:

$$Pr(X_C \leq c) = \Phi\left(\frac{ln(c) - \mu}{\sigma}\right) \tag{4}$$

where:

X_C	=	A randomly chosen detected measurement.
$\Phi(\cdot)$	=	The cumulative distribution function of the standard normal distribution.
μ and σ	=	Parameters of the log-normal distribution (the mean and standard deviation of the log-transformed concentrations).

The expected value, $E(X_C)$, and the variance, $Var(X_C)$, of the lognormal distribution can be calculated as:

$$E(X_c) = exp\left(\mu + \frac{\sigma^2}{2}\right) \tag{5}$$

$$Var(X_c) = \left(E(X_c)\right)^2 (exp(\sigma^2) - 1) \tag{6}$$

B.3 Combining the Continuous and Discrete Portions

The continuous portion of the modified delta-lognormal distribution is combined with the discrete portion to model data that contain a mixture of non-detected and detected measurements. It is possible to fit a wide variety of observed effluent data to the modified delta-lognormal distribution. Multiple detection limits for non-detect measurements are incorporated, as are measured ("detected") values. The same basic framework can be used even if there are no non-detected values in the dataset (in this case, it is the same as the lognormal distribution). Thus, the modified delta-lognormal distribution offers a large degree of flexibility in modeling effluent data.

The modified delta-lognormal random variable U can be expressed as a combination of three other independent variables as follows:

$$U = I_U X_D + (1 - I_U) X_c \quad (7)$$

where:

X_D	=	A random non-detect from the discrete portion of the distribution.
X_C	=	A random detected measurement from the continuous lognormal portion.
I_U	=	A variable indicating whether any particular random measurement, U, is non-detected or detected (i.e., I_U=1 if u is non-detected, and I_U=0 if u is detected).

Using a weighted sum, the cumulative distribution function from the discrete portion of the distribution (equation 1) can be combined with the function from the continuous portion (equation 4) to obtain the overall cumulative probability distribution of the modified delta-lognormal distribution:

$$Pr(U \le c) = \left(\sum_{i:D_i \le c} \delta_i \right) + (1 - \delta)\Phi\left(\frac{ln(c) - \mu}{\sigma}\right) \quad (8)$$

The expected value of the random variable U can be derived as a weighted sum of the expected values of the discrete and continuous portions of the distribution (equations 2 and 5, respectively) as follows:

$$E(U) = \delta E(X_D) + (1 - \delta)E(X_C) \quad (9)$$

In a similar manner, the expected value of U^2 can be written as a weighted sum of the expected values of the squares of the discrete and continuous portions of the distribution:

$$E(U^2) = \delta E(X_D^2) + (1 - \delta)E(X_C^2) \quad (10)$$

Although written in terms of U, the following relationship holds for all random variables:

$$E(U^2) = Var(U) + \left(E(U)\right)^2 \tag{11}$$

Now using equation (11) to solve for Var(U), and applying the relationships in equations (9) and (10), the variance of U is given by:

$$Var(U) = \delta\left(Var(X_D) + \left(E(X_D)\right)^2\right) + (1-\delta)\left(Var(X_C) + \left(E(X_C)\right)^2\right) - \left(E(U)\right)^2 \tag{12}$$

Thus the modified delta-lognormal distribution can be described by the following parameters: the k distinct detection limits, Di, and their corresponding probabilities, $\delta_i, i = 1, \ldots, k$ and the parameters μ and σ of the lognormal distribution for detected values in the continuous portion of the distribution.

B.4 Autocorrelation

The correlation among daily measurements can be described by the sequence of correlations between observations that are 1 day apart, 2 days apart, 3 days apart, etc. There are many time series models that might be considered for modeling this sequence of correlations and the associated wastewater measurements. One such model is an AR(1) model, an autoregressive model with one parameter, ρ, the correlation between observations one day apart. If the data are consistent with an AR(1) model, the correlation between observations d days apart will be ρ^d. The AR(1) model is a reasonable model for many series of wastewater measurements when applied to the log-transformed concentrations. Based on analysis of the effluent data for this rule, EPA has used the AR(1) model for describing the correlations among the steam electric effluent measurements.

Use of the AR(1) model requires estimating ρ. When the data come from sequential daily samples with no values below the detection limit, ρ can be estimated by the correlation between log-transformed measurements separated by one day. When the data are not from sequential samples, standard statistical software for time series analysis can be used to estimate ρ. When the data also have non-detects, as in the data used to develop this rule, estimates based on standard statistical software can be biased. DCN SE06279 describes the procedures used to estimate the 1-day lag correlation for the effluent data adjusting for the effect of any non-detects.

EPA estimated the 1-day lag correlation for each analyte within each plant for which there were enough data to provide a reasonably precise correlation estimate. When there were two or more plants with correlation estimates for a combination of analyte and treatment option, EPA averaged the correlations to obtain the correlation used for calculating the limitations. Unless specified otherwise, for combinations of analyte and technology option with no correlation estimate, EPA assumed the correlation was zero.

In the equations below, EPA used the correlation to calculate the variance of the long-term concentration series from the variance of the observed measurements. The correlation is also used when calculating the variance of the monthly mean from the variance of the long-term series. As implemented in the equations below, the correlation adjustment affects only the variance of the continuous portion of the modified delta lognormal distribution, and the non-detects are assumed to be statistically independent.

B.5 Plant and Pollutant Dataset Requirements

The parameter estimates for the lognormal portion of the modified delta-lognormal distribution can be calculated with as few as two distinct detected values in a dataset. (In order to estimate the variance of the modified delta-lognormal distribution, at least two distinct detected values are required.)

For this rulemaking, EPA used a plant dataset for a pollutant to calculate the plant-specific LTA and variability factor if the dataset contained three or more observations with at least two distinct detected concentration values. If the plant dataset for a pollutant did not meet these requirements, EPA used an arithmetic average to calculate the plant-specific LTA and excluded the dataset from the variability factor calculations (since the variability could not be calculated in this situation).

B.6 Parameter Estimates for Modified Delta-Lognormal Distribution of Daily Concentrations

To use the modified delta-lognormal model, the parameters of the distribution must be estimated from the data. These estimates are then used to calculate the limitations. The following assumes that the parameter estimates are calculated from *n* observed daily values.

The parameters δ_i and δ are estimated from the data using the following formulas:

$$\hat{\delta}_i = \frac{1}{n}\sum_{j=1}^{n_d} I\left(d_j = D_i\right) \tag{13a}$$

$$\hat{\delta} = \frac{n_d}{n} \tag{13b}$$

where *n* is the number of measurements (both detected and non-detected), $I(\cdot)$ is an indicator function equal to one if the argument is true (and zero otherwise), $d_j, j = 1,\ldots, n_d$, is the detection limit for the j^{th} non-detected measurement, and n_d is the total number of non-detected measurements. The "hat" over the parameters indicates that these values are estimated from the data.

The expected value and the variance of the discrete portion of the modified delta-lognormal distribution can be estimated from the data as:

$$\hat{E}(X_D) = \frac{1}{\hat{\delta}}\sum_{i=1}^{k} \hat{\delta}_i\, D_i \tag{14}$$

$$\hat{V}ar(X_D) = \frac{1}{\hat{\delta}}\sum_{i=1}^{k} \hat{\delta}_i \left(D_i - \hat{E}(X_D)\right)^2 \tag{15}$$

The parameters μ and σ of the continuous portion of the modified delta-lognormal distribution are estimated from the log-transformed data using:

$$\hat{\mu} = \sum_{i=1}^{n_c} \frac{ln(x_i)}{n_c} \tag{16}$$

$$\hat{\sigma}^2 = \frac{1}{g(\rho_c)} \sum_{i=1}^{n_c} \frac{(ln(x_i) - \hat{\mu})^2}{n_c - 1} \tag{17}$$

where:

x_i	=	The i^{th} detected measurement.
n_c	=	The number of detected measurements (note that $n = n_d + n_c$), and $g(\rho_c)$ is the adjustment for autocorrelation based on the 1-day lag correlation of the values in the continuous portion of the modified delta lognormal distribution (ρ_c).The flow rate of the wastestream being discharged, in gallons per day.

For an AR(1) model with a 1-day lag correlation of ρ_c, the correlation (in the log scale) between xi and xj ($i \neq j$) is Corr(ln(xi), ln(xj)) $=\rho_c^{|i-j|}$, where i and j are the sample collection dates. Using this, the adjustment for the autocorrelation is:

$$g(\rho_c) = 1 - \frac{1}{n_c(n_c - 1)} \sum_{i \in T} \sum_{j \in T, j \neq i} \rho_c^{|i-j|} \tag{18}$$

where T = {1,...,n} is the set of dates with observed daily values above the detection limit (i.e., in the continuous portion of the distribution). For an AR(1) model with n sequential daily values, this reduces to:

$$g(\rho_c) = 1 - \left(\frac{2}{n_c(n_c - 1)}\right)\left(\frac{\rho_c}{1 - \rho_c}\right)\left((n_c - 1) - \frac{\rho_c(1 - \rho_c^{\,n-1})}{1 - \rho_c}\right) \tag{19}$$

Note that if the daily values are independent (i.e., autocorrelation is not present in the data), then $g(\rho_c) = 1$.

The expected value and the variance of the lognormal portion of the modified delta-lognormal distribution can be calculated from the parameter estimates as:

$$\hat{E}(X_C) = exp\left(\hat{\mu} + \frac{\hat{\sigma}^2}{2}\right) \tag{20}$$

$$\hat{V}ar(X_C) = \left(\hat{E}(X_C)\right)^2 (exp(\hat{\sigma}^2) - 1) \tag{21}$$

Finally, the expected value and variance of the modified delta-lognormal distribution can be estimated using the following formulas:

$$\hat{E}(U) = \hat{\delta}\hat{E}(X_D) + (1 - \hat{\delta})\hat{E}(X_C) \tag{22}$$

$$\hat{V}ar(U) = \hat{\delta}\left(\hat{V}ar(X_D) + \left(\hat{E}(X_D)\right)^2\right) + (1 - \hat{\delta})\left(\hat{V}ar(X_C) + \left(\hat{E}(X_C)\right)^2\right) - \left(\hat{E}(U)\right)^2 \tag{23}$$

Equations (20) through (23) are particularly important in the estimation of the plant LTAs and variability factors as described in the following sections.

B.6.1 Estimation of Plant-Specific LTA

The plant-specific LTA is calculated as follows:

$$LTA = \hat{E}(U) = \hat{\delta}\hat{E}(X_D) + (1 - \hat{\delta})\hat{E}(X_C) \tag{24}$$

Section B.6 contains all the formulas used for each of the expressions above. In the case where there are less than two distinct detected values, the variance in equation (17) cannot be calculated. In this case, the LTA is calculated as the arithmetic mean of the available data (consisting of detected values and detection limits).

B.6.2 Estimation of the Plant-Specific Daily Variability Factor (VF1)

The plant-specific daily variability factor is the ratio of the 99th percentile of the daily concentrations to the LTA and is calculated as follows:

$$VF1 = \frac{\hat{P}_{99}}{\hat{E}(U)} = \frac{\hat{P}_{99}}{LTA} \tag{25}$$

The following describes how the 99th percentile of the modified delta-lognormal distribution is estimated, including how multiple detection limits are accounted for when estimating the 99th percentile.

The cumulative distribution function, p, for a given value c is:

$$Pr(U \leq c) = \left(\sum_{i:D_i \leq c} \hat{\delta}_i\right) + (1 - \hat{\delta})\Phi\left(\frac{ln(c) - \hat{\mu}}{\hat{\sigma}}\right) \tag{26}$$

Under the modified delta-lognormal distribution, if $D_1 < D_2 < \ldots < D_k$ are the k observed detection limits expressed in increasing order, then the cumulative distribution at each detection limit is:

$$\hat{q}_m = \left(\sum_{i=1}^{m} \hat{\delta}_i\right) + (1-\hat{\delta})\Phi\left(\frac{ln(D_m) - \hat{\mu}}{\hat{\sigma}}\right), \qquad m = 1 \ldots k \tag{27}$$

If all k of the $\hat{q}_m$ values are below 0.99, then

$$\hat{P}_{99} = exp\left(\hat{\mu} + \hat{\sigma} \cdot \Phi^{-1}\left(\frac{0.99 - \hat{\delta}}{1 - \hat{\delta}}\right)\right) \tag{28}$$

where $\Phi^{-1}(p)$ is the p^{th} percentile of the standard normal distribution. Otherwise, find j such that D_j is the smallest detection limit for which $\hat{q}_j \geq 0.99$, and let $\hat{q}^* = \hat{q}_j - \hat{\delta}_j$. Then the 99th percentile is:

$$\hat{P}_{99} = \begin{cases} D_j & if\ \hat{q}^* < 0.99 \\ exp\left(\hat{\mu} + \hat{\sigma} \cdot \Phi^{-1}\left(\frac{0.99 - \sum_{i=1}^{j-1} \hat{\delta}_i}{1 - \hat{\delta}}\right)\right) & if\ \hat{q}^* \geq 0.99 \end{cases} \tag{29}$$

B.7 Parameter Estimates for Modified Delta-Lognormal Distribution of Monthly Averages

To calculate the 4-day variability factor (VF4), EPA assumed that the approximating distribution of $\overline{U}_4$, the sample mean for a random sample of four independent concentrations, was also derived from the modified delta-lognormal distribution in which the discrete portion corresponds to averages of four non-detects (assumed to be independent) and the continuous portion approximates the distribution of averages involving detected values (which may be correlated). The probability that the average involves four non-detects is:

$$\hat{\delta}_4 = \hat{\delta}^4 \tag{30}$$

To obtain the expected value of the mean of the four daily values, equation (22) is modified to indicate that it applies to the average:

$$\hat{E}(\overline{U}_4) = \hat{\delta}_4\left(\hat{E}(\overline{X}_4)_D\right) + (1 - \hat{\delta}_4)\hat{E}(\overline{X}_4)_C \tag{31}$$

where:

$(\overline{X}_4)_D$ = The mean of the discrete portion of the distribution of the average of four independent concentrations (i.e., when all observations are non-detected).

$(\bar{X}_4)_C$ = The mean of the continuous lognormal portion (i.e., for averages involving one or more detected observations). The flow rate of the wastestream being discharged, in gallons per day.

First, EPA assumed that the detection of each measurement is independent. Therefore, the probability of the detection of the measurements can be written as $\hat{\delta}_4 = \hat{\delta}^4$. Because the measurements are assumed to be independent, the following relationships hold:

$$\hat{E}((\bar{X}_4)_D) = \hat{E}(X_D) \qquad (32)$$
$$\hat{V}ar((\bar{X}_4)_D) = \frac{\hat{V}ar(X_D)}{4}$$

Since the expected value of the daily concentrations and the monthly means are equal:

$$\hat{E}(\bar{U}_4) = \hat{E}(U) \qquad (33)$$

The variance of the monthly average (represented by $\hat{V}ar(\bar{U}_4)$) with the correlation adjustment is:

$$\hat{V}ar(\bar{U}_4) = \frac{\hat{V}ar(U)}{4}(1 + f_4(\rho_c)) \qquad (34)$$

where the factor $f_4(\rho_c)$ is used to adjust for the correlation among the four values in the average. This adjustment factor is shown below. Note that the correlation adjustment $(1 + f_4(\rho_c))$ is equal to 1.0 if the correlation is zero. Although the calculation of the adjustment factor assumes all four weekly concentrations are detected (by using the correlation among detected values), in practice the observations used to calculate the monthly average may include non-detects.

In general, for a monthly average of m samples:

$$f_m(\rho_c) = \frac{1}{m}\sum_{i\in S}\sum_{j\in S, i\neq j}\frac{exp\left(\rho_c^{|i-j|}\hat{\sigma}^2\right) - 1}{exp(\hat{\sigma}^2) - 1} \qquad (35)$$

Where S represents the set of sampling dates within the month.

When four samples are collected 7 days apart, the correlation between detected values 7 days apart is ρ_c^7 and equation (35) is equal to:

$$f_4(\rho_c) = \frac{2}{4}\sum_{k=1}^{3}(4 - k)\left(\frac{exp(\rho_c^{7k}\hat{\sigma}_A^2) - 1}{exp(\hat{\sigma}_A^2) - 1}\right) \qquad (36)$$

Substituting into equation (31) and solving for the expected value of the continuous portion of the distribution gives:

$$\hat{E}(\bar{X}_4)_C = \frac{\hat{E}(U) - \hat{\delta}_4 \hat{E}(X_D)}{1 - \hat{\delta}_4} \qquad (37)$$

Using the relationship in equation (23) for the averages of four daily values, substituting terms from equations (32) to (34) and solving for the variance of the continuous portion of $\bar{U}_4$ gives:

$$\hat{V}ar((\bar{X}_4)_C) = \frac{\hat{V}ar(\bar{U}_4) + \left(\hat{E}(U)\right)^2 - \hat{\delta}_4\left(\hat{V}ar((\bar{X}_4)_D) + \left(\hat{E}(X_D)\right)^2\right)}{1 - \hat{\delta}_4} - \left(\hat{E}((\bar{X}_4)_C)\right)^2 \qquad (38)$$

Using equations (20) and (21) and solving for the parameters of the lognormal distribution describing the distribution of $(\bar{X}_4)_C$ gives:

$$\hat{\sigma}_4^2 = ln\left(\frac{\hat{V}ar((\bar{X}_4)_C)}{\left(\hat{E}((\bar{X}_4)_C)\right)^2} + 1\right)$$

$$\hat{\mu}_4 = ln\left(\hat{E}((\bar{X}_4)_C)\right) - \frac{\hat{\sigma}_4^2}{2} \qquad (39)$$

The average of four non-detects can generate an average that is not necessarily equal to any of the $D_1, D_2, \ldots, D_k$. Consequently, more than k discrete points exist in the discrete portion of the distribution of the 4-day averages. For example, the average of four non-detects when there are k=2 distinct detection limits are at the following discrete k^* points with the associated probabilities denoted by δ_i^*, i=1,…, k^*:

i	**Value of $\bar{U}_4$ (D_i^*)**	**Probability of occurrence (δ_i^*)**
1	D_1	δ_1^4
2	$(3D_1 + D_2)/4$	$4\delta_1^3\delta_2$
3	$(2D_1 + 2D_2)/4$	$6\delta_1^2\delta_2^2$
4	$(D_1 + 3D_2)/4$	$4\delta_1\delta_2^3$
5 (=k^*)	D_2	δ_2^4

When all four observations are non-detected values, and when k distinct non-detected values exist, the multinomial distribution can be used to determine associated probabilities, as shown below:

$$Pr\left(\overline{U}_4 = \frac{\sum_{i=1}^{k} u_i D_i}{4}\right) = \frac{4!}{u_1!\,u_2!\cdots u_k!}\prod_{i=1}^{k}\delta_i^{u_i} \qquad (40)$$

where u_i is the number of non-detected measurements at the detection limit D_i. The number k^* of possible discrete averages for k=1,…,5, are as follows:

K	*k**
1	1
2	5
3	15
4	35
5	70

B.7.1 Estimation of Plant-Specific Monthly Variability Factors (VF4)

Plant-specific monthly variability factors were based on 4-day monthly averages because EPA assumed the monitoring frequency to be weekly (approximately four times a month). The plant-specific monthly variability factor for each plant is the ratio of a 95th percentile to the LTA. In this case, the parameter to be estimated is the 95th percentile of the distribution of $\overline{U}_4$, which represents the average of four samples for a given plant. The monthly variability factor is calculated as follows:

$$VF4 = \frac{\hat{P}_{95}}{\hat{E}(U)} = \frac{\hat{P}_{95}}{LTA} \qquad (41)$$

Below is a description of how the 95th percentile is estimated under the assumption that $\overline{U}_4$ has a modified delta-lognormal distribution. The following steps also show how EPA accounted for multiple detection limits (for non-detected values) when estimating the 95th percentile of the monthly average.

The approach to estimating P_{95} is similar to the approach used to estimate P_{99} in the calculation of daily variability factors, as described above. For m = 1, …, k*, let

$$\hat{q}_m = \left(\sum_{i=1}^{m}\hat{\delta}_i^*\right) + (1-\hat{\delta}^4)\Phi\left(\frac{ln(D_m^*) - \hat{\mu}_4}{\hat{\sigma}_4}\right) \qquad (42)$$

where $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution.

Now, if all *k* values of $\hat{q}_m$ defined above are less than 0.95, then the 95th percentile is defined as:

$$\hat{P}_{95} = exp\left(\hat{\mu}_4 + \hat{\sigma}_4 \cdot \Phi^{-1}\left(\frac{0.95 - \hat{\delta}^4}{1 - \hat{\delta}^4}\right)\right) \qquad (43)$$

where $\Phi^{-1}(p)$ is the p^{th} percentile of the standard normal distribution. Otherwise, let D_j^* denote the smallest of the k^* values of D_i^* for which $\hat{q}_j \geq 0.95$, and let $\hat{q}^* = \hat{q}_j - \hat{\delta}_j^*$. Then, the 95th percentile is defined by the following:

$$\hat{P}_{95} = \begin{cases} D_j^* & if\ \hat{q}^* < 0.95 \\ exp\left(\hat{\mu}_4 + \hat{\sigma}_4 \cdot \Phi^{-1}\left(\frac{0.95 - \sum_{i=1}^{j-1} \hat{\delta}_i^*}{1 - \hat{\delta}^4}\right)\right) & if\ \hat{q}^* \geq 0.95 \end{cases} \qquad (44)$$

B.8 Evaluation of Plant-Specific Variability Factors

The parameter estimates for the lognormal portion of the distribution can be calculated with as few as two distinct measured values in a dataset (to calculate the variance); however, these estimates can be imprecise (as can estimates from larger datasets). As stated in Section B.5, EPA developed plant-specific variability factors for datasets that had three or more observations with two or more distinct measured concentration values.

To identify situations producing unexpected results, EPA reviewed all of the variability factors and compared daily to monthly variability factors. EPA used several criteria to determine if the plant-specific daily and monthly variability factors should be included in calculating the option variability factors (the option variability factors refer to the technology option variability factor for a pollutant rather than regulatory option). One criterion that EPA used was that the daily and monthly variability factors should be greater than 1.0. A variability factor less than 1.0 would result in an unexpected result where the estimated 99th percentile would be less than the LTA. This would be an indication that the estimate of σ (the standard deviation in log scale) was particularly large and most likely imprecise. A second criterion was that not all of the sample-specific detection limits could exceed the detected values. A third criterion was that the daily variability factor had to be greater than the monthly variability factor. All plant-specific variability factors used for the limitations and standards met these three criteria.

B.9 References

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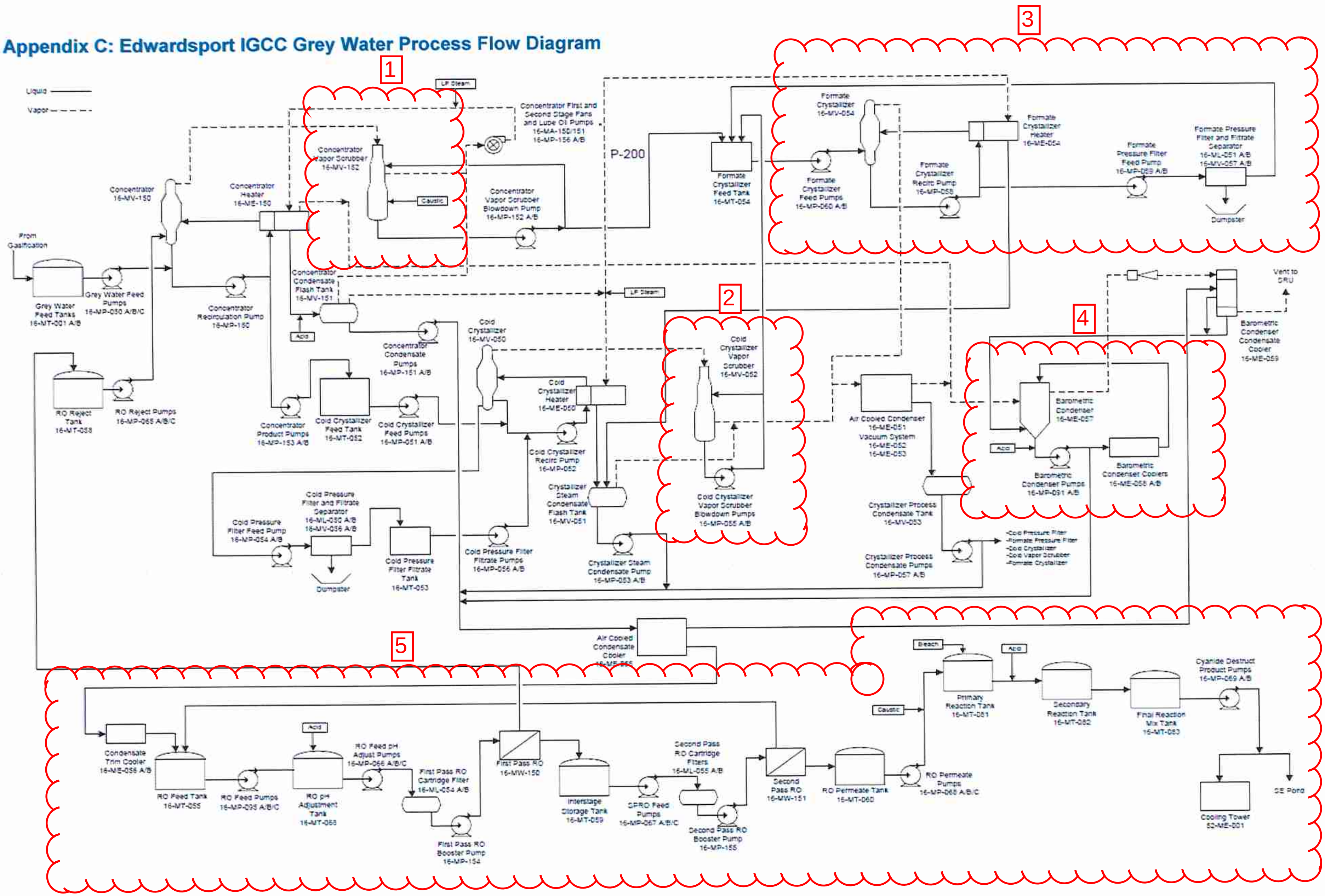
Attachment 13

Edwardsport Grey Water Treatment System Diagram, as Amended by EPA to Highlight Differences to Polk and Wabash Treatment Systems

Appendix C: Edwardsport IGCC Grey Water Process Flow Diagram



Edwardsport IGCC Grey Water Process Flow Diagram Comment Notes

1) Concentrator Vapor Scrubber: Designed to remove volatile acids and entrained droplets from the concentrator vapor stream prior to condensation. The blowdown from the scrubber is sent to the formate crystallizer (see Comment 3). Polk and Wabash do not operate vapor scrubbers.

2) Cold Crystallizer Vapor Scrubber: Designed to remove carryover in the vapor stream. Polk and Wabash do not operate crystallizer vapor scrubbers.

3) Formate Crystallizer and Pressure Filter: Designed to cycle up the blowdown wastestreams from the concentrator and crystallizer scrubber systems. Crystallized sodium formate is generated in the pressure filter and removed from the system.

4) Barometric Condenser: Designed to pressurize vapor streams to enhance condensation of vaporized substances before the vapor streams are utilized in sulfur recovery unit. Polk and Wabash do not operate a barometric condenser and simply vent the gases to the atmosphere.

5) Reverse Osmosis System and Optional Cyanide Destruction System: Designed for the removal of ammonia and total dissolved solids. The RO is a two-pass system. The optional cyanide destruction system is not currently used at the plant.