COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

THE APPLICATION OF KENTUCKY UTILITIES	**)**	
COMPANY FOR CERTIFICATES OF PUBLIC	**)**	
CONVENIENCE AND NECESSITY AND	**)**	
APPROVAL OF ITS 2016 COMPLIANCE PLAN	**)**	**CASE NO. 2016-00026**
FOR RECOVERY BY ENVIRONMENTAL	**)**	
SURCHARGE	**)**	

KENTUCKY UTILITIES COMPANY

RESPONSE TO THE
COMMISSION STAFF'S SECOND REQUEST FOR INFORMATION

DATED APRIL 8, 2016

FILED: APRIL 20, 2016

VERIFICATION

COMMONWEALTH OF KENTUCKY)
) SS:
COUNTY OF JEFFERSON)

The undersigned, **R. Scott Straight**, being duly sworn, deposes and says that he is the Director of Project Engineering for Louisville Gas and Electric Company and Kentucky Utilities Company and an employee of LG&E and KU Services Company, that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

R. Scott Straight

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 20th day of April 2016.

Notary Public (SEAL)

My Commission Expires:

JUDY SCHOOLER
Notary Public, State at Large, KY
My commission expires July 11, 2018
Notary ID # 512743

VERIFICATION

COMMONWEALTH OF KENTUCKY)
) SS:
COUNTY OF JEFFERSON)

The undersigned, **John N. Voyles, Jr.**, being duly sworn, deposes and says that he is the Vice President, Transmission and Generation Services for Louisville Gas and Electric Company and Kentucky Utilities Company and an employee of LG&E and KU Services Company, that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

John N. Voyles, Jr.

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 20th day of April 2016.

(SEAL)
Notary Public

My Commission Expires:
JUDY SCHOOLER
Notary Public, State at Large, KY
My commission expires July 11, 2018
Notary ID # 512743

VERIFICATION

COMMONWEALTH OF KENTUCKY)
) SS:
COUNTY OF JEFFERSON)

The undersigned, **Gary H. Revlett**, being duly sworn, deposes and says that he is Director – Environmental Affairs for LG&E and KU Services Company, and that he has personal knowledge of the matters set forth in the responses for which he is identified as the witness, and the answers contained therein are true and correct to the best of his information, knowledge and belief.

Gary H Revlett

Gary H. Revlett

Subscribed and sworn to before me, a Notary Public in and before said County and State, this 20th day of April 2016.

Judy Schooler (SEAL)

Notary Public

My Commission Expires:

JUDY SCHOOLER
Notary Public, State at Large, KY
My commission expires July 11, 2018
Notary ID # 512743

KENTUCKY UTILITIES COMPANY

Response to Commission Staff's Second Request Dated April 8, 2016

Case No. 2016-00026

Question No. 1

Witness: R. Scott Straight

Q-1. Refer to the Direct Testimony of Robert M. Conroy, page 6, line 8, and the Direct Testimony of R. Scott Straight, page 5, lines 7-8, both of which discuss Project 37 improvements to the wet flue-gas desulfurization unit ("WFGD") for Ghent Unit 2. The statements focus on increasing the liquid flow in the WFGD system and mention replacing pump drive gearboxes as an option in accomplishing that result. Provide details concerning the purpose of this replacement, including whether additional pump items will require replacement in conjunction with the gearboxes, and whether other options have been considered to achieve the same or similar purpose. If other options have been considered, identify those options and state how efficient each option is in achieving the purpose.

A-1. The statements refer to the potential need to replace the pump drive gearboxes, including minor changes associated with the gearbox changes such as couplings and possibly foundation modifications, if the planned modifications to the spray nozzles and wall-rings do not achieve the project's goals for SO_2 removal rates. As stated previously, the purpose of the spray nozzles and wall-rings is to increase the effectiveness of the current liquid-to-gas ratio of the slurry by increasing the contact area of the limestone slurry to the combustion gases. If needed, the purpose of the gearbox replacement would be to increase the actual slurry flow rate of the existing recycle pumps, thus increasing the liquid-to-gas ratio while the nozzles and wall-rings continued to increase the contact area of the slurry. No additional options to the recycle pump gearboxes are being considered.

KENTUCKY UTILITIES COMPANY

Response to Commission Staff's Second Request Dated April 8, 2016

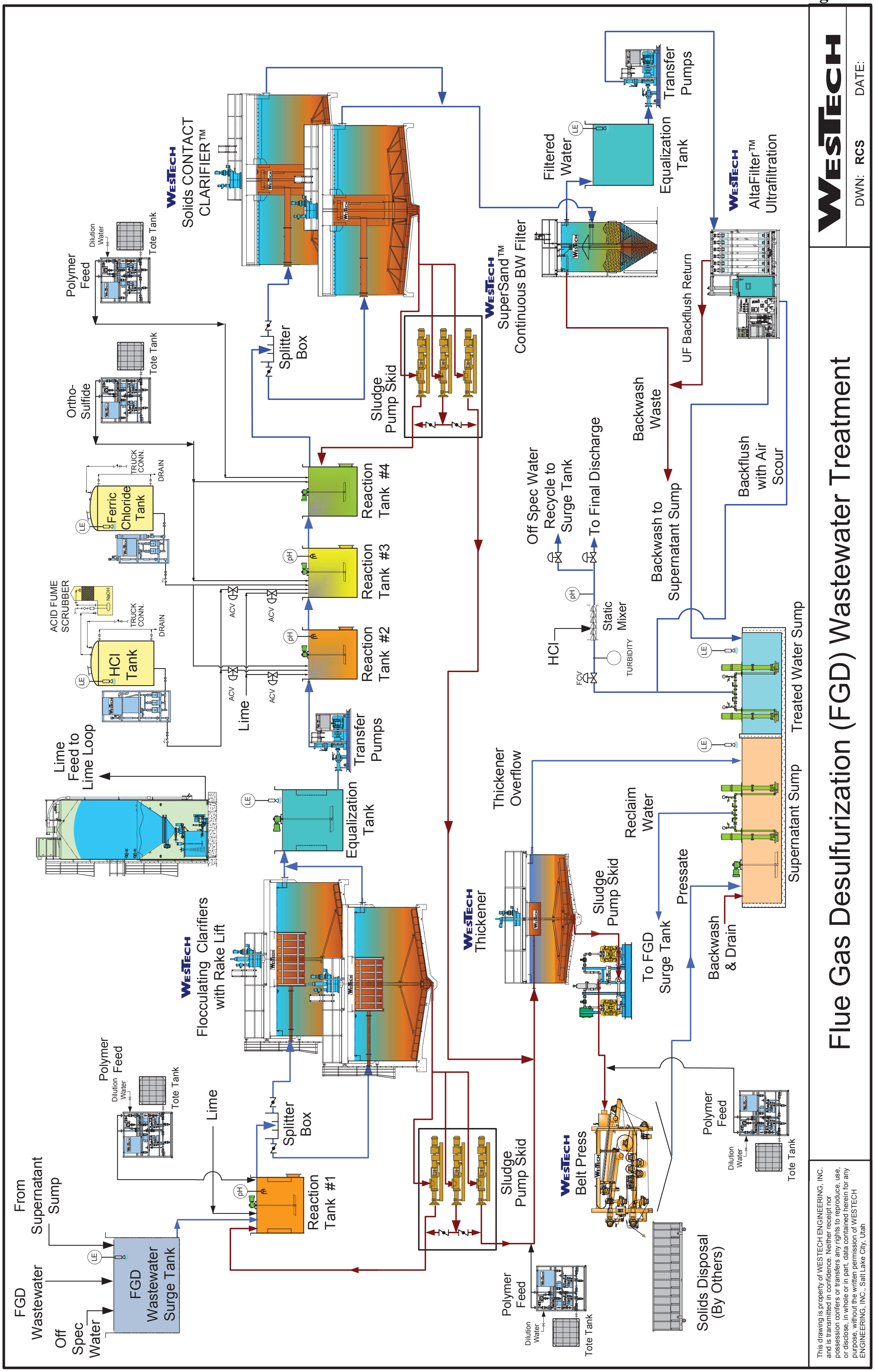
Case No. 2016-00026

Question No. 2

Witness: John N. Voyles, Jr.

Q-2. Refer to the Direct Testimony of John N. Voyles ("Voyles Testimony"), page 27, lines 1-7, concerning process water system construction. Explain in detail whether process water systems are constructed of individually designed components on site, or whether appropriate package systems are available for purchase and installation.

A-2. The process-water systems will be a station-specific design based on the volume of specific process-water streams to be treated. Designs will incorporate as much commonality of processes between all stations as possible, and will likely include a combination of individually designed and sized components and packaged sub-systems to meet the needs of that generating station's specific constituents and permitted discharge limits. See attached for one sample process-water system (generic illustration of water treatment technologies) that contains individually designed components and packaged sub-systems provided by potential technology vendor WesTech.


Flue Gas Desulfurization (FGD) Wastewater Treatment
WesTech
DWN: RCS
DATE:
FGD Wastewater
Off Spec Water
From Supernatant Sump
FGD Wastewater Surge Tank
Reaction Tank #1
Lime
Polymer Feed
Dilution Water
Tote Tank
Splitter Box
WesTech Flocculating Clarifiers with Rake Lift
Sludge Pump Skid
Equalization Tank
Transfer Pumps
Lime Feed to Lime Loop
Reaction Tank #2
Reaction Tank #3
Reaction Tank #4
ACV
HCl Tank
ACID FUME SCRUBBER
NaOH
TRUCK CONN.
DRAIN
Ferric Chloride Tank
Ortho-Sulfide
WesTech Solids CONTACT CLARIFIER™
WesTech SuperSand™ Continuous BW Filter
Filtered Water
Equalization Tank
Transfer Pumps
WesTech AltaFilter™ Ultrafiltration
UF Backflush Return
Backwash Waste
Backflush with Air Scour
Off Spec Water Recycle to Surge Tank
To Final Discharge
Backwash to Supernatant Sump
HCl
FCV
TURBIDITY
Static Mixer
Treated Water Sump
Supernatant Sump
WesTech Thickener
Thickener Overflow
Reclaim Water
Pressate
To FGD Surge Tank
Backwash & Drain
WesTech Belt Press
Solids Disposal (By Others)
This drawing is property of WESTECH ENGINEERING, INC. and is transmitted in confidence. Neither receipt nor possession confers or transfers any rights to reproduce, use, or disclose, in whole or in part, data contained herein for any purpose, without the written permission of WESTECH ENGINEERING, INC., Salt Lake City, Utah

The ***SuperSand™ Filter*** employs a backwash rise that is performed continually while the tank is processing water. An air lift pump located at the center of the module draws the media from the bottom of the filter up into the wash box. As the media is released into the wash box, it falls into the sand scrubber where the filtered solids are separated from the sand. From there, the filtrate carries the solids out as waste. The washed sand falls down into the media bed for continued use.

Flue Gas Desulfurization (FGD), Wet Scrubber, Wastewater Treatment

Flue gas desulfurization removes sulfur dioxide from fossil fuel flue gases. Wet-scrubbing transfers the pollutants to a liquid which is treated before waterway discharge. The scrubbing solution is usually lime and a concentrated solution of calcium sulfate is produced. Blowdown is required to keep the solution below saturation so that scaling does not occur.

5 Steps of FGD Wastewater Treatment

1. pH Elevation / Metal & Gypsum Desaturation

Desaturating the stream of metals and gypsum is important to prevent scaling on equipment and is performed by dilution and lowering the temperature (remember that calcium salts are inversely soluble). The pH of the wastewater stream is then raised to between 8-10 using calcium hydroxide ($Ca(OH)_2$) or sodium hydroxide (NaOH). Dissolved metals form hydroxides which precipitate as solids.

The lime or caustic is added to precipitate gypsum from the stream. Sludge is recycled from the downstream clarifier to provide seed for gypsum crystallization.

2. Heavy Metal Removal

Some heavy metals are removed as hydroxides as pH is raised. Small waste stream pH adjustment is normally accomplished through caustic addition rather than lime slurry. The use of caustic saves capital costs and reduces sludge production.

Organosulfides or sodium sulfides may be added to further precipitate heavy metals. Metal sulfides have much lower solubility than metal hydroxides. These compounds are also very effective in removing mercury down to parts per trillion levels.

3. Coagulation / Polymer / pH Adjustment

Ferric chloride is added to neutralize charged particles, allowing flocs to form and enhancing clarifier performance. This may also precipitate other metals and organic matter. Polymer addition aids in larger floc formation, further enhancing clarifier performance. The wastewater is clarified by a WesTech Flocculating Clarifier. A rake lift is provided since inlet solids can be as high as 2%. The pH is adjusted to normal using hydrochloric acid (HCL). HCL is used because no additional sulfate needs to be added.

4. Solids CONTACT CLARIFIER™

The metal precipitates must now be removed from the waste stream. Since there is a relatively low amount of solids, it is necessary to use a Solids CONTACT CLARIFIER™ for this purpose. The Solids CONTACT CLARIFIER™ has an impeller-driven sludge recycle stream. This draws sludge from the tank bottom through a draft tube into the reaction well. This impeller acts as a high flow, low shear pump. The recycle stream is sized to 10 times the inlet flow and has suspended solids of 10,000 ppm. Incoming particles contact previously flocculated solids, yielding high removal rates. Blowdown sludge from the Solids CONTACT CLARIFIER™ is recycled to a mix tank in the feed stream. This promotes additional floc formation and solids removal.

Gravity media filtration may be used if a low suspended solids level is required prior to wastewater discharge. In this case, filter backwash is returned to the front of the wastewater treatment system.

5. Solids Dewatering

The clarifier sludge typically contains 3-5 weight percent of solids. This contains inert material and precipitated metals which are pumped to a thickener to increase the solids percentage. Volume dewatering requirements determine the choice of recessed chamber filter presses or belt presses.

KENTUCKY UTILITIES COMPANY

Response to Commission Staff's Second Request Dated April 8, 2016

Case No. 2016-00026

Question No. 3

Witness: John N. Voyles, Jr.

Q-3. Refer to the Voyles Testimony, the Exhibits prepared by CH2M HILL, Inc. Typically, it is stated that the cost estimates for the studies are +30 percent/-30 percent, and include a 30 percent contingency. Confirm that the 30 percent contingency is in the total capital cost before applying the +30 percent/-30 percent high and low factors.

A-3. The Commission's assumption is correct. The typical "Total Initial Costs," as shown on the Cost Summary page of the CH2M Hill, Inc. reports, includes 30 percent contingency. The 30 percent contingency line-item is located on the cost-estimate spreadsheets and is applied to line-item estimates developed by CH2M. This is typical for all the cost estimates. The +30 percent/-30 percent is then applied to the Total Initial Costs, to reflect the accuracy of conceptual costs estimates.

The 30 percent level of contingency is in line with the level of engineering performed (up to 5% of engineering effort) to develop the costs estimates. Using generally accepted industry practices and AACE Internal Cost Estimate Classification System (see attached), the conceptual cost estimates provided are considered Class 4 "Study or Feasibility." The accuracy of Class 4 cost estimates can range from minus 15-30 percent to plus 20-50 percent. CH2M and KU agreed to use +30 percent/-30 percent for the estimates in the Exhibits. As project development and further engineering proceed, the level of contingency and cost-estimate accuracy will be refined.

Please see Section 5 of each of the Exhibits from the CH2M for additional details related to the level of engineering effort and the accuracy of the cost estimates.

AACE International Recommended Practice No. 18R-97

COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

Rev. March 1, 2016

Note: As AACE International Recommended Practices evolve over time, please refer to www.aacei.org for the latest revisions.

Contributors:

Disclaimer: The opinions expressed by the authors and contributors to this recommended practice are their own and do not necessarily reflect those of their employers, unless otherwise stated.

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COST ESTIMATE CLASSIFICATION SYSTEM – AS APPLIED IN ENGINEERING, PROCUREMENT, AND CONSTRUCTION FOR THE PROCESS INDUSTRIES

TCM Framework: 7.3 – Cost Estimating and Budgeting

March 1, 2016

PURPOSE

As a recommended practice of AACE International, the *Cost Estimate Classification System* provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The *Cost Estimate Classification System* maps the phases and stages of project cost estimating together with a generic project scope definition maturity and quality matrix, which can be applied across a wide variety of process industries.

This addendum to the generic recommended practice (17R-97) provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the process industries. This addendum supplements the generic recommended practice by providing:

- A section that further defines classification concepts as they apply to the process industries.
- A chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic recommended practice, the intent of this addendum is to improve communications among all of the stakeholders involved with preparing, evaluating, and using project cost estimates specifically for the process industries.

The overall purpose of this recommended practice is to provide the process industry with a project definition deliverable maturity matrix that is not provided in 17R-97. It also provides an approximate representation of the relationship of specific design input data and design deliverable maturity to the estimate accuracy and methodology used to produce the cost estimate. The estimate accuracy range is driven by many other variables and risks, so the maturity and quality of the scope definition available at the time of the estimate is not the sole determinate of accuracy; risk analysis is required for that purpose.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally acceptable classification system for process industries that can be used as a basis to compare against. This addendum should allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

INTRODUCTION

For the purposes of this addendum, the term "process industries" is assumed to include firms involved with the manufacturing and production of chemicals, petrochemicals, and hydrocarbon processing. The common thread among these industries (for the purpose of estimate classification) is their reliance on process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) as primary scope defining documents. These documents are key deliverables in determining the degree of project definition, and thus the extent and maturity of estimate input information.

Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this addendum may apply to portions of other industries, such as pharmaceutical, utility, water treatment, metallurgical, converting, and similar industries.

This addendum specifically does not address cost estimate classification in non-process industries such as commercial building construction, environmental remediation, transportation infrastructure, hydropower, “dry” processes such as assembly and manufacturing, “soft asset” production such as software development, and similar industries. It also does not specifically address estimates for the exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate processing steps in these systems.

The cost estimates covered by this addendum are for engineering, procurement, and construction (EPC) work only. It does not cover estimates for the products manufactured by the process facilities, or for research and development work in support of the process industries. This guideline does not cover the significant building construction that may be a part of process plants.

This guideline reflects generally-accepted cost engineering practices. This RP was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed, and the practices were found to have significant commonalities. These classifications are also supported by empirical process industry research of systemic risks and their correlation with cost growth and schedule slip[8].

COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

A purpose of cost estimate classification is to align the estimating process with project stage-gate scope development and decision making processes.

Table 1 provides a summary of the characteristics of the five estimate classes. The maturity level of project definition is the sole determining (i.e., primary) characteristic of class. In Table 1, the maturity is roughly indicated by a percentage of complete definition; however, it is the maturity of the defining deliverables that is the determinant, not the percent. The specific deliverables, and their maturity or status are provided in Table 3. The other characteristics are secondary and are generally correlated with the maturity level of project definition deliverables, as discussed in the generic RP [2]. The post sanction classes (Class 1 and 2) are only indirectly covered where new funding is indicated. Again, the characteristics are typical and may vary depending on the circumstances.

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Table 1 – Cost Estimate Classification Matrix for Process Industries

This matrix and guideline outline an estimate classification system that is specific to the process industries. Refer to the generic estimate classification RP[1] for a general matrix that is non-industry specific, or to other addendums for guidelines that will provide more detailed information for application in other specific industries. These will provide additional information, particularly the project definition deliverable maturity matrix which determines the class in those particular industries.

Table 1 illustrates typical ranges of accuracy ranges that are associated with the process industries. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically to achieve a 50% probability of project overrun versus underrun) for given scope. Depending on the technical and project deliverables (and other variables) and risks associated with each estimate, the accuracy range for any particular estimate is expected to fall into the ranges identified (although extreme risks can lead to wider ranges).

In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as:

- Level of non-familiar technology in the project.
- Complexity of the project.
- Quality of reference cost estimating data.
- Quality of assumptions used in preparing the estimate.
- Experience and skill level of the estimator.
- Estimating techniques employed.
- Time and level of effort budgeted to prepare the estimate.
- Unique/remote nature of project locations and the lack of reference data for these locations.
- The accuracy of the composition of the input and output process streams.

Systemic risks such as these are often the primary driver of accuracy, especially during the early stages of project definition. As project definition progresses, project-specific risks (e.g. risk events) become more prevalent and also drive the accuracy range[3]. Another concern in estimates is potential pressure for a predetermined value that may result in a biased estimate. The goal should be to always have an unbiased and objective estimate. The stated estimate ranges are dependent on this premise and a realistic view of the project.

Failure to appropriately address systemic risks (e.g. technical complexity) during risk analysis impacts the resulting probability distribution of the estimate costs, and therefore the interpretation of estimate accuracy.

Another way to look at the variability associated with estimate accuracy ranges is shown in Figure 1. Depending upon the technical complexity of the project, the availability of appropriate cost reference information, the degree of project definition, and the inclusion of appropriate contingency determination, a typical Class 5 estimate for a process industry project may have an accuracy range as broad as -50% to +100%, or as narrow as -20% to +30%.

Figure 1 also illustrates that the estimating accuracy ranges overlap the estimate classes. There are cases where a Class 5 estimate for a particular project may be as accurate as a Class 3 estimate for a different project. For example, similar accuracy ranges may occur if the Class 5 estimate of one project that is based on a repeat project with good cost history and data and, whereas the Class 3 estimate for another is for a project involving new technology. It is for this reason that Table 1 provides ranges of accuracy range values. This allows application of the specific circumstances inherent in a project, and an industry sector, to provide realistic estimate class accuracy range percentages. While a target range may be expected of a particular estimate, the accuracy range is determined through risk analysis of the specific project and is never pre-determined. AACE has recommended practices that address contingency determination and risk analysis methods.

If contingency has been addressed appropriately, approximately 80% of projects should fall within the ranges shown in Figure 1. However, this does not preclude a specific actual project result from falling inside or outside of the bands shown in Figure 1 indicating the expected accuracy ranges.

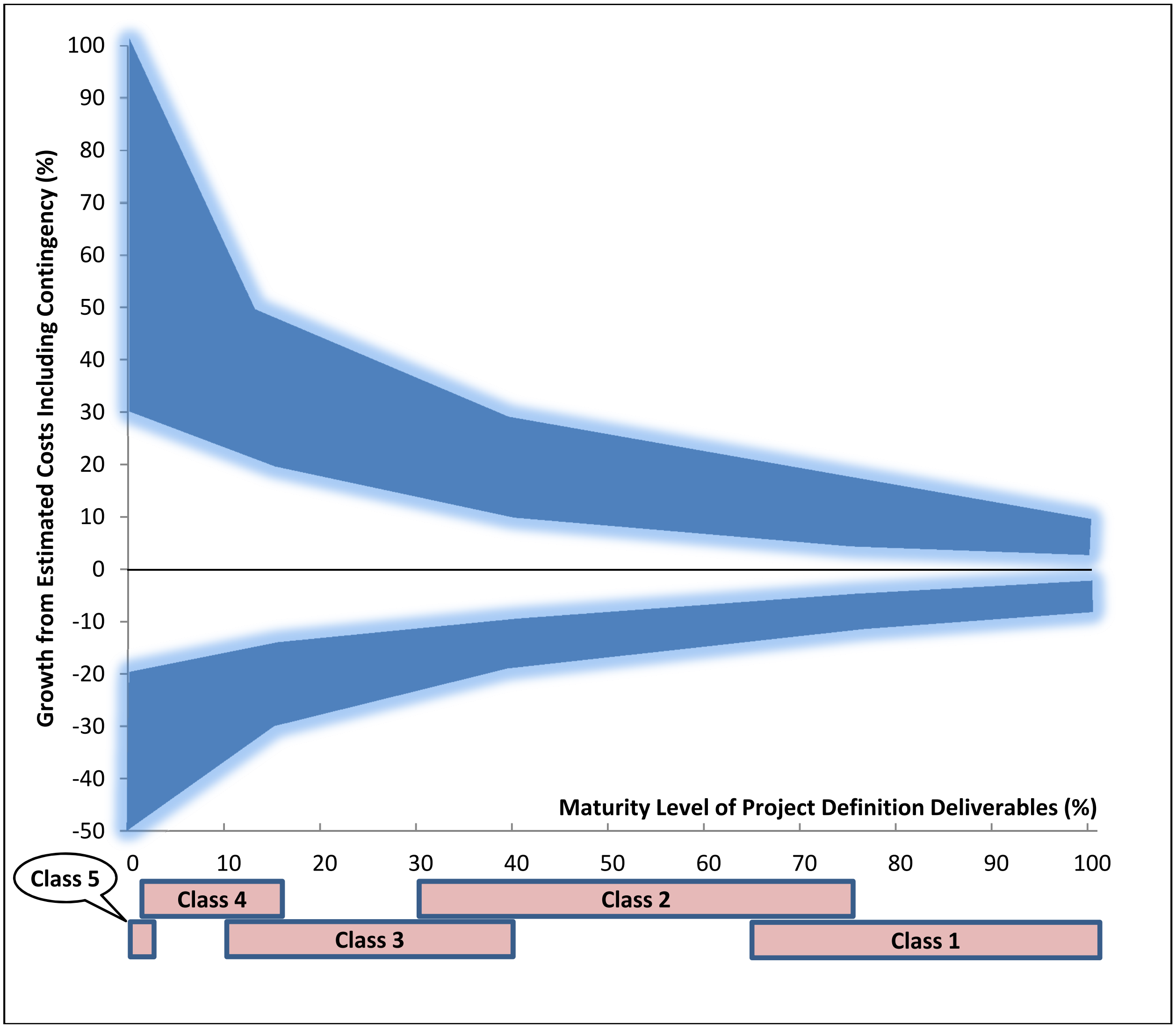


Figure 1 – Example of the Variability in Accuracy Ranges for a Process Industry Estimate

DETERMINATION OF THE COST ESTIMATE CLASS

The cost estimator makes the determination of the estimate class based upon the maturity level of project definition based on the status of specific key planning and design deliverables. The percent design completion may be correlated with the status, but the percentage should not be used as the estimate class determinant. While the determination of the status (and hence the estimate class) is somewhat subjective, having standards for the design input data, completeness and quality of the design deliverables will serve to make the determination more objective.

KENTUCKY UTILITIES COMPANY

Response to Commission Staff's Second Request Dated April 8, 2016

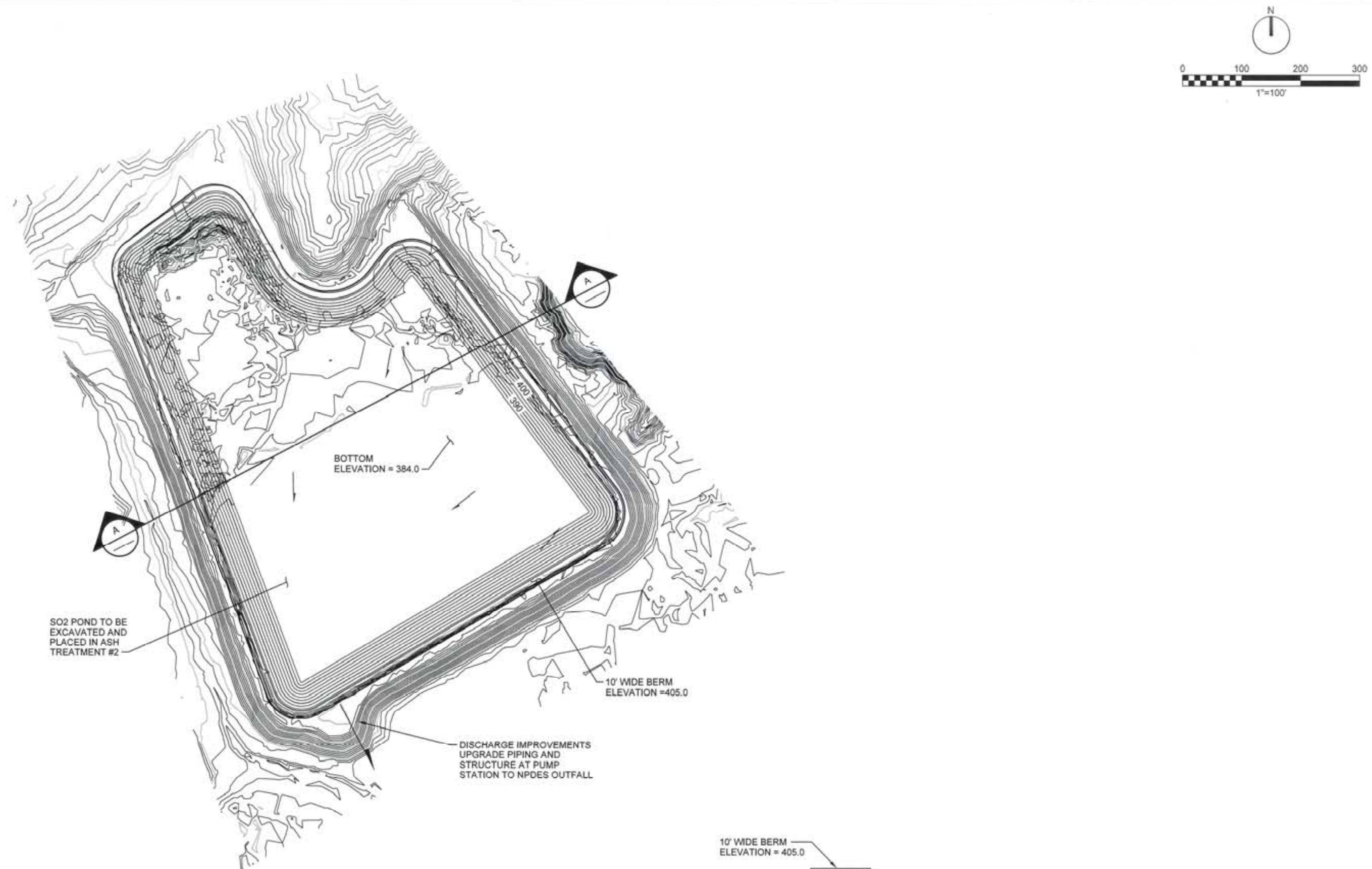
Case No. 2016-00026

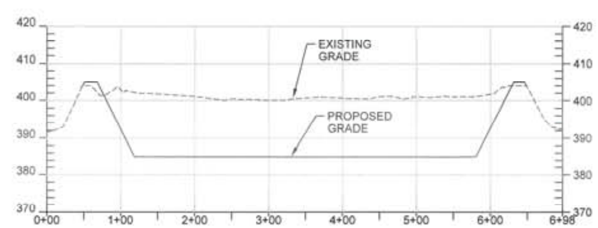
Question No. 4

Witness: John N. Voyles, Jr.

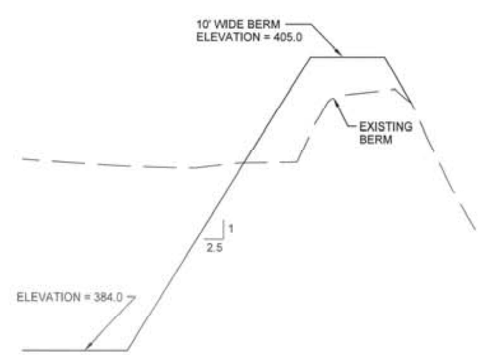
Q-4. Refer to the Voyles Testimony, Exhibit JNV-3, page 12, Section B. Confirm that the elevation dimensions are incorrect, and if so, provide correct elevation dimensions.

A-4. KU confirms the Bottom Elevation of 484.0, as shown in the Plan View and Section B, is incorrect. The referenced page has been updated to show the correct Bottom elevation of 384.0. See attached.





A SECTION
SCALE: 1" = 100' HORIZ
1" = 20' VERT



B SECTION
NTS

PRELIMINARY ENGINEERING
NOT FOR CONSTRUCTION

ITEM	UNITS	SO2 POND
TOTAL SURFACE AREA	ACRES	10.1
LENGTH OF PERIMETER	LINEAR FEET	2780
CUT	CUBIC YARDS	198,736
FILL TO FINAL GRADE	CUBIC YARDS	-
COVER FILL TO FINAL GRADE	CUBIC YARDS	17,892
EXCESS MATERIAL (TO ATB2)	CUBIC YARDS	198,736
TOTAL AIRSPACE AVAILABLE	CUBIC YARDS	-

CH2MHILL®

COAL COMBUSTION RESEDUAL EVALUATION
LOUISVILLE GAS AND ELECTRIC COMPANY
AND KENTUCKY UTILITIES
LOUISVILLE, KENTUCKY

NO.	DATE	REVISION	BY	APVD

DSGN | DR | CHK | APVD

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	JULY 2015
PROJ	488248
DWG	
SHEET	of

KENTUCKY UTILITIES COMPANY

Response to Commission Staff's Second Request Dated April 8, 2016

Case No. 2016-00026

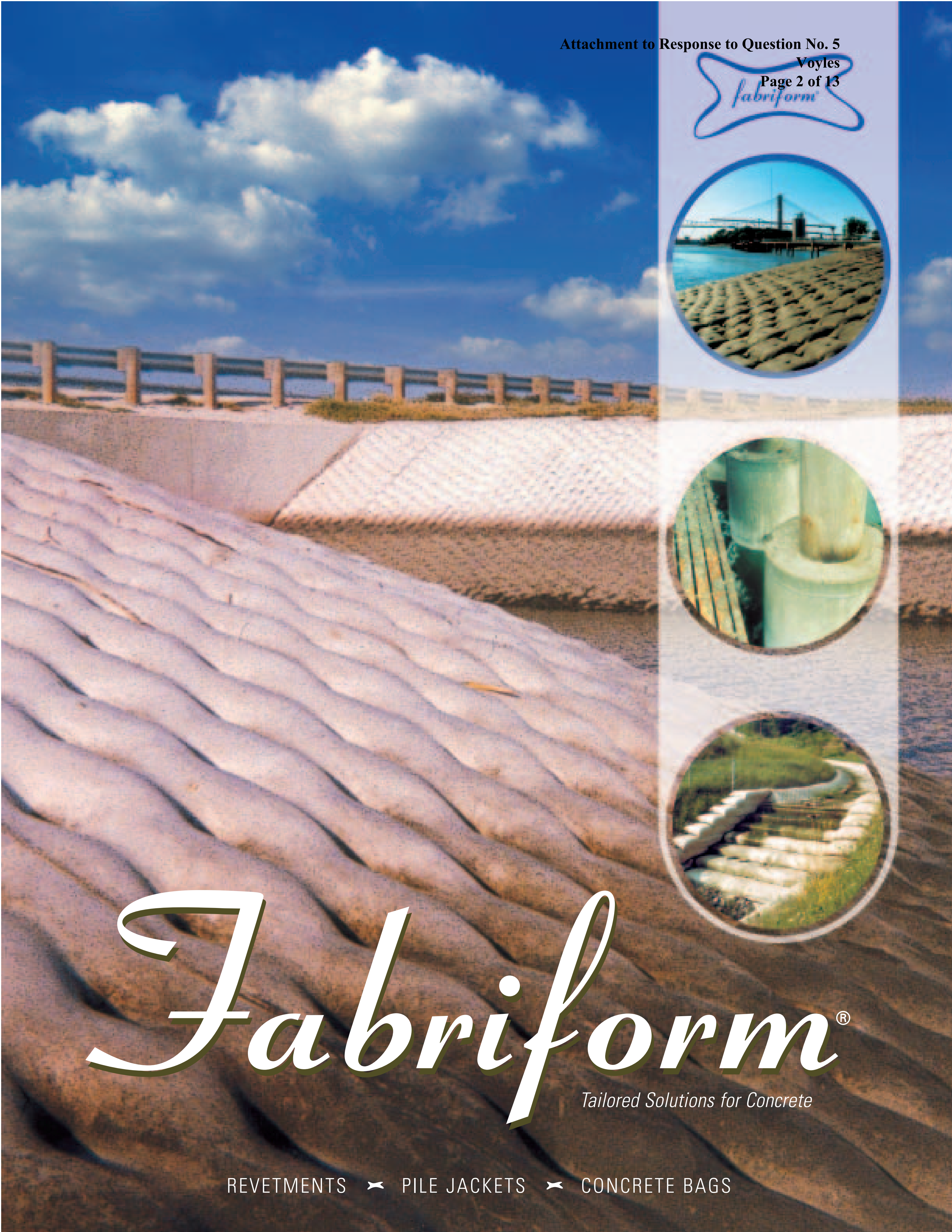
Question No. 5

Witness: John N. Voyles, Jr.

Q-5. Refer to KU's response to Staffs Initial Request for Information, Item 15. Provide a more detailed description of the concrete Fabricform protective cover used as a component of the liner system being addressed.

A-5. The Fabriform referenced in KU's response to the Staff's Initial Request for Information, Item 15, is a specific product provided by Construction Techniques, Inc. However, for the purposes of this ECR filing, Fabriform is equivalent to any fabric form concrete system.

The fabric form concrete system (fabric form) is the top layer when utilized in a liner system. The fabric form consists of specially woven fabric "envelopes" that are pumped full of a highly fluid concrete mix. The use of fabric form eliminates the need for a soil protective cover over top of the liner system and allows the repurposed or new ponds to undergo routine maintenance activities. Typical maintenance includes dredging via long reach excavators and hydraulic dredges. The use of fabric form provides a hard protective barrier between the mechanical dredging equipment and the liner system, whereas a soil protective cover does not provide a hard protective barrier to the liner system. Fabric form has been successfully used on the Ghent and E.W. Brown landfill projects as erosion control in ditches and as protective cover in pond liner systems. See attached photo of fabric form in use at E.W. Brown as well as the manufacturer's literature on Fabriform Filterpoint and Unimat by Construction Techniques, Inc.


fabriform
Fabriform®
Tailored Solutions for Concrete
REVETMENTS
PILE JACKETS
CONCRETE BAGS

WHAT IS FABRIC–FORMED CONCRETE?

Fabric-formed concrete is the result of pumping a highly fluid concrete mix into specially woven fabric "envelopes." This method of erosion-control allows for fast, economical construction of revetments, landfill containment systems, holding ponds, bridge scour repair, bridge or dock piling reinforcement and countless other applications.

This innovative technique utilizes fabric woven of high tenacity nylon yarn into a variety of forms including mats, pile jackets and bags. At the work site, the custom-made forms are positioned and sewn together with hand-held sewing machines. They are then pumped with fine aggregate concrete and allowed to cure.

Fabric-formed concrete eliminates the need for time-consuming wooden forms. Plus, fabric forms have the unique advantage of allowing the concrete to be pumped and cured below the water line — making site preparation much easier. Labor and material costs are reduced due to simpler installation and more efficient use of concrete. This efficiency makes fabric-formed concrete "budget-friendly" by design.

In addition to economical advantages, fabric-formed concrete is the smart choice for erosion control because of its high versatility, durability and effectiveness. Worldwide, there are millions of square feet of fabric-formed concrete in place.

WHY CHOOSE FABRIFORM?

Fabriform® is the original fabric-formed concrete system. The Fabriform system was developed and patented by Construction Techniques in the mid-1960's. Forty years later, Construction Techniques continues to manufacture Fabriform to the highest standards of quality.

Not all fabric is created equal. The Fabriform system utilizes double-layer, *high-tenacity nylon* fabric, specially woven for optimum strength, stability, adhesion and filtering characteristics. These qualities are necessary to withstand pumping pressure during installation and to ensure resistance to the strong alkalis present in concrete.

In addition to quality, Fabriform is a great value because it is manufactured "in-house." That is, Construction Techniques operates the mill that weaves and assembles the various styles of Fabriform. This not only ensures quality control, it helps control costs — making high-quality Fabriform highly competitive.

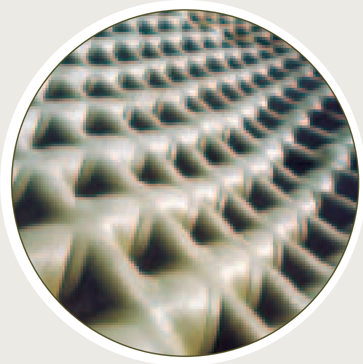
As the patent-holder of Fabriform, a pioneer in fabric-formed concrete systems, Construction Techniques is the most experienced and trusted name in the industry. With over 100 years of combined experience in the sale, manufacture and service of Fabriform products, the staff of Construction Techniques is well-prepared to advise you on your next project. Allow us to put our experience to work for you.

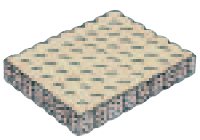
THREE FABRIC STYLES FOR REVETMENTS:

Filterpoint

For maximum attenuation of hydraulic energy and relief of hydrostatic uplift.

Filterpoint revetments are characterized by aesthetically appealing cobbled surfaces. Woven filterpoints (5", 8" or 10" centers when cast-in-place) between cobbles relieve hydrostatic uplift pressure and each revetment exhibits a high coefficient of hydraulic friction. The majority of erosion control applications utilize the 8" (200mm) filterpoint revetment. The light 5" (130mm) filterpoint style fabric is available for constructing thinner revetments in less demanding areas such as the shorelines for small ponds and drainage ditches. The 10" (250mm) filterpoint provides a heavy duty mat when severe abrasion is anticipated or additional weight is advisable.

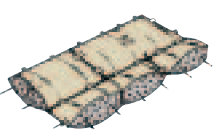




Unimat

For minimum hydraulic friction and maximum impermeability.

Unimat revetments are characterized by a slightly dimpled surface. These revetments exhibit a relatively low coefficient of hydraulic friction. Permeability approximates that of high quality concrete paving. Unimat style fabric for construction of 3" (75mm), 4" (100mm) and 6" (150mm) thick revetments is carried in inventory. Fabric for other revetments from 8" (200mm), 10" (250mm) and 12" (300mm) thickness is available on special order. Criteria for selection of unimat revetment is the same as that employed in determining the thickness of concrete paving.



Articulating Block

For slopes subject to severe underscour or consolidation.

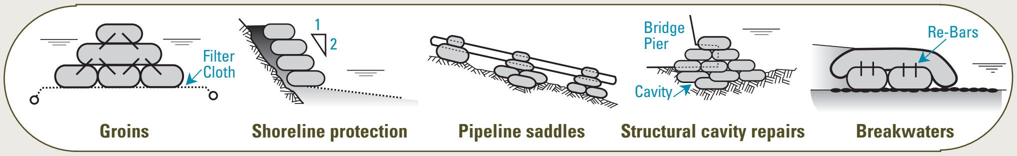
AB revetments consist of rectangular concrete blocks cast in place in a staggered pattern and can be linked together by reinforcing cables inserted between the two layers of fabric prior to mortar injection. Cables allow the revetment to articulate with changing soil and water conditions. AB style fabrics for construction of an average 4" (100mm), 6" (150mm) and 8" (200mm) thickness are carried in inventory. If required, nylon rope cables in sizes to meet design requirements are installed in the assembled panels.

All Fabriform® fabrics are manufactured with 100% continuous multifilament, high-tenacity nylon for stability and resistance to the strong alkalis present in concrete and are woven such that at least 50% by weight consists of textured fibers for optimum filtering characteristics and adhesion to mortar.

Concrete Bags

Fabric forms to solve tough concrete forming problems.

Fabriform Concrete Bags are the most versatile concrete forming system available. Retaining Walls, Spillways, Pipe Saddles or void/cavity forms on any volume are just a few of the applications for Concrete Bags. Construction Techniques custom tailors all Bags to accommodate required dimensions. As with all Fabriform processes, Concrete Bags can be cast underwater as well as in the dry.



Pile Jackets

Zippered fabric forms for marine pile repair.

Fabriform Pile Jackets are a strong lightweight concrete form used in marine pile rehabilitation. Jackets are custom assembled to project requirements to fit any length and size of steel, timber or concrete piles. Pile jackets lower production costs in three ways: 1) Preassembled, no form fabrication required, 2) Easy to handle, requires no lifting equipment and 3) Forms bleed excess mixing water. A lower water/cement ratio provides exceptional concrete durability.

CONTACT INFORMATION

With over *100 years* of combined experience in the sale, manufacture and service of Fabriform products, the staff of Construction Techniques is well-prepared to advise you on your next project. Allow us to put our experience to work for you. For more information, contact us today or visit our website.

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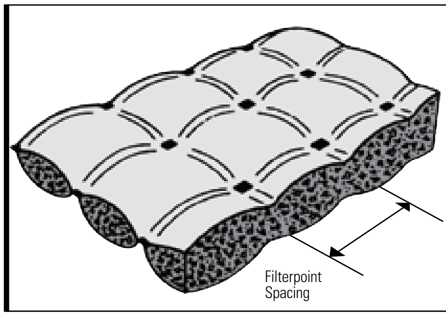
Fabric Forms for Concrete: Erosion Control Revetments

The FABRIFORM® Process utilizes a double-layer, 100% nylon fabric form, especially woven for optimum strength, stability, adhesion, and filtering characteristics, combined with a highly fluid fine aggregate concrete (grout) to provide an economical hard armor solution for erosion control. Fabriform revetments can be cast underwater as well as in-the-dry.

Fabriform® Filterpoint Technical Data

DESIGNS BASED ON OVER 40 YEARS OF EXPERIENCE



Designation Style	CAST-IN-PLACE							
	Filterpoint Spacing		Average Thickness*		Coverage Per		Dry Weight**	
	in.	mm	in.	mm	Y^3 Mortar	M^3 Mortar	lb / ft^2	kg / m^2
5″ FPNN	5	127	2.2	56	135 ft^2	16.39 m^2	25	122
8″ FPNN	8	200	4	100	75 ft^2	9.11 m^2	45	220
10″ FPNN	10	250	6	150	50 ft^2	6.07 m^2	68	330

* Nominal
** Dry Weight based on a specific weight of 2.1 or 135 lb/cf. Unit Weight may vary with material proportions and source.

Filterpoint (FP) revetment fabric is a form for casting in place fine aggregate concrete (grout) revetments. Characterized by a deeply cobbled surface, these rigid revetments exhibit a relatively high coefficient of hydraulic friction which is well suited to attenuation of hydraulic energy. The woven filter points permit escape of ground water to relieve hydrostatic uplift.

Filterpoint revetment fabrics are woven of 100% high-tenacity, multifilament nylon of which at least 50% by weight consists of textured fibers for optimum filtering characteristics and adhesion to the grout. These fibers have an excellent long-term performance record in the critical areas where the two layers of fabric are joined together to form the filter points. Nylon yarns also provide a relatively high resistance to ultraviolet light and alkali degradation.

The Filterpoint revetment fabric is shop-assembled in predetermined panel sizes to fit site topography. The panels are convenient to handle and are joined together side-by-side at the job site by means of sewing or zipper closures attached to both the upper and lower layers of fabric.

The panels will contract when they are injected with grout. Allowance must be made for this contraction when preparing shop drawings of panel assemblies. Contraction will vary with site conditions. For budgetary estimates, a minimum contraction allowance should be made for approximately 21% additional fabric to cover the cast-in-place area.

NOTE:

Information contained in this publication is offered in good faith as a guide to placement of Fabriform® erosion control revetments. It is based on experience obtained under a variety of conditions. However, information contained herein will not apply to every job and dimensions and quantities shown are approximate only and will vary as a result of site conditions and installation procedures. The user is cautioned to obtain from others such professional and technical services as may, in his own judgment, be necessary or desirable to insure effective and economical installations.

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I. GENERAL

A. Scope of Work

The work shall consist of furnishing all labor, materials, and equipment for installing fabric-formed concrete revetment as indicated in the contract drawings and specified herein.

B. Description

The work shall consist of installing an unreinforced concrete revetment, as indicated in the contract drawings, by positioning a specially woven, dual wall, 100% nylon fabric form on the slope or surface to be protected and injecting it with fine aggregate concrete (grout). The surfaces to be protected shall be prepared and graded to such an extent that they are normally stable in the absence of erosive forces.

C. Qualification of Contractor

The Contractor shall furnish records of past successful experience in performing this type of work. The Contractor shall save the Owner harmless from liability of any kind arising from the use of any patented or unpatented invention in the performance of this work.

II. MATERIALS

A. Fiber and Fabric Specifications

Fiber and fabric materials shall meet the minimum requirements, as listed and reported by an independent testing agency, shown below:

PROPERTY	TEST METHOD	UNIT	VALUE	
PHYSICAL				
Composition			NYLON	
Weight (both layers)	ASTM D-5261	oz/yd (g/m)	13 (440)	
Thickness	ASTM D-5199	mils (mm)	30 (0.76)	
MECHANICAL				
Grab Tensile Strength	ASTM D-4632	lbf (N)	WARP FILL	400 (1780) 250 (1110)
Grab Tensile Elongation	ASTM D-4632	%	WARP FILL	30 30
Wide Width Strip Tensile Strength	ASTM D-4595	lbf/in (kN/m)	WARP FILL	300 (52.5) 200 (35)
Elongation At Break	ASTM D-4595	%	WARP FILL	15 20
Trapezoidal Tear Strength	ASTM D-4533	lbf (N)	WARP FILL	175 (775) 150 (665)
HYDRAULIC				
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Standard (mm)	40 (0.425)	
Flow Rate	ASTM D-4491	gal/min/sf (l/min/m)	90 (3665)	

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B. Fabric Design

Fabric-forming material shall consist of double-layer, open-selvage fabric joined in a mat configuration. Fabric shall be woven of 100% high-tenacity, continuous multifilament nylon of which at least 50% by weight shall be textured fiber. Polyester, staple, and partially orientated yarn shall not be allowed.

Filterpoint Fabric, designated as ______FPNN on the drawings, shall be woven in such a manner as to provide interwoven points of attachment on spaced centers. *(See Note 1 below)* These points of attachment shall serve to control the thickness of the revetment and also act as "Filter Points" to provide relief of hydrostatic uplift pressure beneath the revetment. The filter points shall be woven in a basket or other open weave to allow improved permittivity.

Thickness of the finished revetment shall be measured as described in Section III.D of these specifications.

Note 1: Designer will indicate here the fabric designation required from choice of fabric styles below. Fabric style designates approximate spacing of filter points cast in place in the completed revetment:

5" FPNN, 8" FPNN, 10" FPNN

C. Fabric Porosity

Fabric porosity is essential for the successful execution of this work. At the direction of the Engineer, the Contractor shall demonstrate the suitability of fabric design by injecting the proposed grout into 5½" (140 mm) diameter sleeves. The sleeves shall be constructed of a single layer of the same basic fabric material. Test cylinders, 12"(300 mm) long, shall be cut from each specimen and tested in accordance with ASTM C-39. This test will be run once at the start of the project unless otherwise directed by the engineer. (See Item E below)

D. Fabric Assembly

The FP fabric can be factory sewn into predetermined custom sized panels. The FP fabric rolls are first cut into the lengths specified on the shop drawings. These fabric pieces are then joined together, top layer to top layer and bottom layer to bottom layer. This will allow for the finished revetment to have the full mat thickness between the top and bottom seam. A single seam in which all four layers of fabric are joined at one point will not be permitted. All factory seams shall face downwards and shall be made using a double-needled machine utilizing the Standard Type 401 stitch. If required, bulkheads (grout stops) may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of fine aggregate concrete. Grout stops shall be designed as to produce full mat thickness along the full length of the grout stop. Completed FP panels shall be inspected to verify that the proper filter point spacing is maintained throughout the panel.

E. Fine Aggregate Concrete (Grout)

Fine aggregate concrete (grout) shall consist of a mixture of portland cement, fine aggregate, and water so proportioned and mixed as to provide a readily flowable grout. Admixtures and/or a pozzolan may be used with the approval of the Engineer. Use of super plasticizers requires special precautions; silica fume is not recommended. The hardened fine aggregate concrete shall exhibit a compressive strength of 2,500 psi (17 MPa) at 28 days when specimens are made and tested according to the provisions of ASTM C-31 and C-39. The average compressive strength of fabric cast test cylinders, as described in Paragraph C above, shall be at least 20% higher at 7 days than that of companion test cylinders made in accordance with ASTM C-31, and not less than 3,000 psi (21 MPa) at 28 days.

III. INSTALLATION

A. Fabric Storage

Immediately following receipt of fabric on the job site, fabric shall be inspected and stored in a clean, dry area where it will not be subject to mechanical damage or exposure to moisture or direct sunlight. Fabric allowed to become wet and then dried before installation will be subject to shrinkage.

B. Site Preparation

The surface to be protected shall be constructed to the line and dimensions as shown on the contract drawings. The area shall be free of all obstruction and organic material, such as rocks and roots. Areas below grade shall be brought to grade using engineered fill or a drainage stone as specified by the Engineer. Anchor and flank trench installation will be in accordance with project plans and specifications.

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C. Fabric Placement

The FP fabric panels shall be positioned over a geotextile filter fabric, as specified by the Engineer, at their approximate design location. The factory assembled panels shall be joined in the field by means of sewing or zipper closures. Adjacent panels shall be joined top layer to top layer and bottom layer to bottom layer. The contractor must make the appropriate allowance for approximately 10% contraction of the fabric in each direction which will occur as a result of grout injection. If joining of panels as described above is impractical, adjacent panels may be overlapped a minimum of 3 feet (900 mm), subject to Engineer's approval. In no case will simple butt joints between panels be allowed. However, a modified butt joint where an underlayment of similar fabric is sewn to one panel and overlapped a minimum of 2 feet (600mm) by the adjacent panel is allowed subject to Engineer's approval.

D. Fine Aggregate Concrete (Grout) Injection

Following placement of FP fabric panels over the geotextile filter cloth, fine aggregate concrete (grout) shall be injected between the upper and lower layers of fabric through small slits cut in the upper layer of fabric. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap during pumping. First pump the upper edge of the mat which as been placed in the anchor trench followed by injection into the lower edge, working back up the slope. Avoid overpressuring of the fabric. After pumping, the burlap shall be pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of grout on the revetment surface. The burlap seal shall be removed prior to the final set of the fine aggregate concrete and the injection area hand-finished. The sequence of grout injection shall be such as to ensure complete filling of the revetment-forming fabric to the thickness specified by the fabric manufacturer.

Foot traffic will not be permitted on the freshly pumped mat when such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary.

Excessive grout which has been inadvertently spilled on the mat surface shall be cleaned up with a broom and shovel. Use of a water hose to remove spilled grout from the surface of a freshly pumped mat will not be permitted.

During grout injection, the mat thickness may be measured by inserting a short piece of stiff wire through the mat at several locations from the crest to the toe of the slope. Any mat measuring less than 90% of the average of all thickness measurements shall be re-injected until desired average thickness has been attained.

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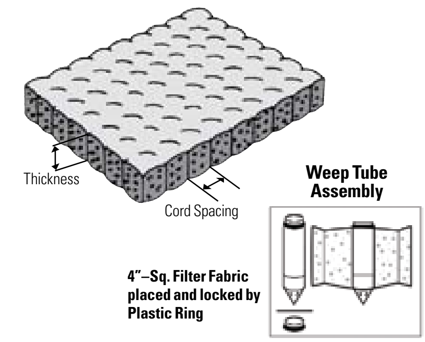
Fabriform® Unimat Technical Data

DESIGNS BASED ON OVER 40 YEARS OF EXPERIENCE



Designation Style	CAST-IN-PLACE						
	Cord Spacing	Average Thickness*		Coverage Per		Dry Weight**	
		in.	mm	Y^3 Mortar	M^3 Mortar	lb / ft^2	kg / m^2
3" UMNN	3" x 3.5"	3	75	100 ft^2	12.14 m^2	34	166
4" UMNN	3" x 3.5"	4	100	75 ft^2	9.11 m^2	45	220
6" UMNN	3" x 6"	6	150	50 ft^2	6.07 m^2	68	330
8" UMNN	3" x 6"	8	200	38 ft^2	4.55 m^2	90	440

* Nominal
** Dry Weight based on a specific weight of 2.1 or 135 lb/cf. Unit Weight may vary with material proportions and source.

Uniform Cross Section (Unimat) revetment fabric is a form for casting in place fine aggregate concrete (grout) revetments. Characterized by a slightly dimpled surface, these rigid revetments exhibit a relatively low coefficient of hydraulic friction. Permeability is equivalent to that of high quality concrete paving. The criterion for selection of Unimat revetment thickness is the same as that employed in determining the thickness of conventional concrete paving.

Unimat revetment fabrics are woven of 100% high-tenacity, multifilament nylon of which at least 50% by weight consists of textured fibers for optimum filtering characteristics and adhesion to the grout. These fibers have an excellent long-term performance record. Nylon yarns also provide a relatively high resistance to ultraviolet light and alkali degradation.

The Unimat revetment fabric is shop-assembled in predetermined panel sizes to fit site topography. The panels are convenient to handle and are joined together side-by-side at the job site by means of sewing or zipper closures attached to both the upper and lower layers of fabric.

The panels will contract when they are injected with grout. Allowance must be made for this contraction when preparing shop drawings of panel assemblies. Contraction will vary with site conditions. For budgetary estimates, a minimum contraction allowance should be made for approximately 8% additional fabric to cover the cast-in-place area.

NOTE:

Information contained in this publication is offered in good faith as a guide to placement of Fabriform® erosion control revetments. It is based on experience obtained under a variety of conditions. However, information contained herein will not apply to every job and dimensions and quantities shown are approximate only and will vary as a result of site conditions and installation procedures. The user is cautioned to obtain from others such professional and technical services as may, in his own judgment, be necessary or desirable to insure effective and economical installations.

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I. GENERAL

A. Scope of Work

The work shall consist of furnishing all labor, materials, and equipment for installing fabric-formed concrete revetment as indicated in the contract drawings and specified herein.

B. Description

The work shall consist of installing an unreinforced concrete revetment, as indicated in the contract drawings, by positioning a specially woven dual wall, 100% nylon fabric form on the slope or surface to be protected and injecting it with fine aggregate concrete (grout). The surfaces to be protected shall be prepared and graded to such an extent that they are normally stable in the absence of erosive forces.

C. Qualification of Contractor

The Contractor shall furnish records of past successful experience in performing this type of work. The Contractor shall save the Owner harmless from liability of any kind arising from the use of any patented or unpatented invention in the performance of this work.

II. MATERIALS

A. Fiber and Fabric Specifications

Fiber and fabric materials shall meet the minimum requirements, as listed and reported by an independent testing agency, shown below:

PROPERTY	TEST METHOD	UNIT	VALUE	
PHYSICAL				
Composition			NYLON	
Weight (both layers)	ASTM D-5261	oz/yd (g/m)	13 (440)	
Thickness	ASTM D-5199	mils (mm)	30 (0.76)	
MECHANICAL				
Grab Tensile Strength	ASTM D-4632	lbf (N)	WARP FILL	400 (1780) 250 (1110)
Grab Tensile Elongation	ASTM D-4632	%	WARP FILL	30 30
Wide Width Strip Tensile Strength	ASTM D-4595	lbf/in (kN/m)	WARP FILL	300 (52.5) 200 (35)
Elongation At Break	ASTM D-4595	%	WARP FILL	15 20
Trapezoidal Tear Strength	ASTM D-4533	lbf (N)	WARP FILL	175 (775) 150 (665)
HYDRAULIC				
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Standard (mm)	40 (0.425)	
Flow Rate	ASTM D-4491	gal/min/sf (l/min/m)	90 (3665)	

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B. Fabric Design

Fabric-forming material shall consist of double-layer, open-selvage fabric joined in a mat configuration. Fabric shall be woven of 100% high-tenacity, continuous multifilament nylon of which at least 50% by weight shall be textured fiber. Polyester, staple, and partially orientated yarn shall not be allowed.

Unimat Fabric, designated as _______UMNN on the drawings, shall be woven in such a manner with nylon spacer cords to provide points of attachment on specific centers. *(See Note 1 below)* The spacer cords shall serve to control the thickness of the revetment without bursting the fabric during fine aggregate injection.

Thickness of the finished revetment shall be measured as described in Section III.D of these specifications.

Note 1: Designer will indicate here the fabric designation required from choice of fabric styles below. Fabric style designates the nominal thickness of the cast-in-place revetment:

3" UMNN, 4" UMNN, 6" UMNN, 8" UMNN

C. Fabric Porosity

Fabric porosity is essential for the successful execution of this work. At the direction of the Engineer, the Contractor shall demonstrate the suitability of fabric design by injecting the proposed grout into 5½" (140 mm) diameter sleeves. The sleeves shall be constructed of a single layer of the same basic fabric material. Test cylinders, 12"(300 mm) long, shall be cut from each specimen and tested in accordance with ASTM C-39. This test will be run once at the start of the project unless otherwise directed by the engineer. (See Item F below)

D. Relief of Hydrostatic Uplift

Where groundwater conditions require provision for relief of hydrostatic uplift, 7/8" (22mm) I.D. weep tube assemblies shall be inserted through the fabric. These weep tube assemblies shall be held in place during grout injection by means of a snap on collar attached to the lower end of the weep tube assembly. If the revetment has not been placed over a geotextile filter cloth, the lower end of the weep tube assembly shall be covered with a piece of filter cloth. The weep tube assemblies shall be located as called for on the plans.

E. Fabric Assembly

The Unimat fabric can be factory sewn into predetermined custom sized panels. The fabric rolls are first cut into the lengths specified on the shop drawings. These fabric pieces are then joined together, top layer to top layer and bottom layer to bottom layer. This will allow for the finished revetment to have the full mat thickness between the top and bottom seam. A single seam in which all four layers of fabric are joined at one point will not be permitted. All factory seams shall face downwards and shall be made using a double-needled machine utilizing the Standard Type 401 stitch. If required, bulkheads (grout stops) may be installed parallel to and in between individual mill widths at predetermined intervals to regulate the flow of fine aggregate concrete. Grout stops shall be designed as to produce full mat thickness along the full length of the grout stop.

F. Fine Aggregate Concrete (Grout)

Fine aggregate concrete (grout) shall consist of a mixture of portland cement, fine aggregate, and water so proportioned and mixed as to provide a readily flowable grout. Admixtures and/or a pozzolan may be used with the approval of the Engineer. Use of super plasticizers requires special precautions; silica fume is not recommended. The hardened fine aggregate concrete shall exhibit a compressive strength of 2,500 psi (17 MPa) at 28 days when specimens are made and tested according to the provisions of ASTM C-31 and C-39. The average compressive strength of fabric cast test cylinders, as described in Paragraph C above, shall be at least 20% higher at 7 days than that of companion test cylinders made in accordance with ASTM C-31, and not less than 3,000 psi (21 MPa) at 28 days.

III. INSTALLATION

A. Fabric Storage

Immediately following receipt of fabric on the job site, fabric shall be inspected and stored in a clean, dry area where it will not be subject to mechanical damage or exposure to moisture or direct sunlight. Fabric allowed to become wet and then dried before installation will be subject to shrinkage.

B. Site Preparation

The surface to be protected shall be constructed to the line and dimensions as shown on the contract drawings. The area shall be free of all obstruction and organic material, such as rocks and roots. Areas below grade shall be brought to grade using engineered fill or a drainage stone as specified by the Engineer. Anchor and flank trench installation will be in accordance with project plans and specifications.

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C. Fabric Placement

The Unimat fabric panels shall be positioned, as specified by the Engineer, at their approximate design location. The factory assembled panels shall be joined in the field by means of sewing or zipper closures. Adjacent panels shall be joined top layer to top layer and bottom layer to bottom layer. The contractor must make the appropriate allowance for approximately 4% contraction of the fabric in each direction, which will occur as a result of grout injection. If joining of panels as described above is impractical, adjacent panels may be overlapped a minimum of 3 feet (900 mm), subject to Engineer's approval. In no case will simple butt joints between panels be allowed. However, a modified butt joint where an underlayment of similar fabric is sewn to one panel and overlapped a minimum of 2 feet (600mm) by the adjacent panel is allowed subject to Engineer's approval.

D. Fine Aggregate Concrete (Grout) Injection

Following placement of the Unimat fabric panels, fine aggregate concrete (grout) shall be injected between the upper and lower layers of fabric through small slits cut in the upper layer of fabric. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap during pumping. First pump the upper edge of the mat which as been placed in the anchor trench followed by injection into the lower edge, working back up the slope. Avoid overpressuring of the fabric. After pumping, the burlap shall be pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of grout on the revetment surface. The burlap seal shall be removed prior to the final set of the fine aggregate concrete and the injection area hand-finished. The sequence of grout injection shall be such as to ensure complete filling of the revetment-forming fabric to the thickness specified by the fabric manufacturer.

Foot traffic will not be permitted on the freshly pumped mat when such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary.

Excessive grout which has been inadvertently spilled on the mat surface shall be cleaned up with a broom and shovel. Use of a water hose to remove spilled grout from the surface of a freshly pumped mat will not be permitted.

During grout injection, the mat thickness may be measured by inserting a short piece of stiff wire through the mat at several locations from the crest to the toe of the slope. Any mat measuring less than 90% of the average of all thickness measurements shall be re-injected until desired average thickness has been attained.

KENTUCKY UTILITIES COMPANY

Response to Commission Staff's Second Request Dated April 8, 2016

Case No. 2016-00026

Question No. 6

Witness: Gary H. Revlett

Q-6. Refer to KU's response to Attorney General's Initial Request for Information, Items 6 and 7. The response to Item 7 states that the closure process must be completed in five years. Based on the response to Item 6, if the circumstances are applicable, can extensions to the five-year limit be requested and given?

A-6. No. The response to Item 6 recognized that an extension could be "requested," but in light of the self-implementing nature of the CCR Rule, there is no agency or entity to which such a "request" could be tendered, much less approved. From a practical standpoint, the Company would have to document internally the need for an extension and proceed to defend its position if challenged as if it had been granted. But using such an extension, even if the Company believed it met the applicable criteria, would expose the Company, and ultimately its customers, to additional citizen-suit risk. Because the CCR Rule is self-implementing, citizen suits are the CCR Rule's only enforcement mechanism; relying on additional provisions of the rule, such as the extension provisions, opens the Company to additional avenues of citizen-suit attack.