ARMED SERVICES BOARD OF CONTRACT APPEALS

Appeals of --	)	
	)	
Parsons Main, Inc.	)	ASBCA Nos. 51355, 51717
	)	
Under Contract No. DACA41-94-C-0103	)	

APPEARANCES FOR THE APPELLANT: John B. Tieder, Jr., Esq.
Kathleen O. Barnes, Esq.
Michelle G. Hicks, Esq.
Watt, Tieder, Hoffar & Fitzgerald, L.L.P.
McLean, VA

APPEARANCES FOR THE GOVERNMENT: Frank Carr, Esq.
Engineer Chief Trial Attorney
Emmett C. Wade, Esq.
William M. Edwards, Esq.
Engineer Trial Attorneys
U.S. Army Engineer District, Kansas City

OPINION BY ADMINISTRATIVE JUDGE JAMES

These appeals arise from the contracting officer's (CO) (i) November 1997 final decision claiming $8,733,427 for an allegedly negligent facility foundation design under the captioned architect-engineer (A-E) contract (ASBCA No. 51355), and (ii) August 1998 final decision denying the A-E's $545,952 claim for services to redesign the facility (ASBCA No. 51717). We have jurisdiction of these appeals under the Contract Disputes Act of 1978, 41 U.S.C. § 607. After a six-day hearing at St. Louis, MO, the parties filed post-hearing, reply and sur-reply briefs. We decide entitlement only (tr. 26-27).

FINDINGS OF FACT

1. On 27 May 1994, the U.S. Army Corps of Engineers (COE) awarded contract No. DACA41-94-C-0103 (the A-E contract) to Parsons Main, Inc. (PMI) for the "35% concept design" of a replacement facility for the Defense Mapping Agency, renamed the National Imagery and Mapping Agency (NIMA), near St. Louis, MO. The A-E contract had unpriced COE options for the 65% design, 100% final design, subsurface exploration, and A-E services during construction, and established a $38,400,000 construction contract cost limit. (R4, tab 5 at 1, 4[1])

2. The A-E contract's work scope required field surveys, measurements, design analysis, preparation of construction contract drawings, specifications, and cost estimate in accordance with the following relevant terms:

> 18. GENERAL REQUIREMENTS AND STANDARDS
>
> . . . .
>
> j. Subsurface Exploration. (At the Option of the Government) A Subsurface Investigation and Foundation Analysis shall be provided by the A-E. The Government will furnish investigation requirements and report format . . . .
>
> k. Subsurface Data. A subsurface report shall be included in the design analysis. Boring logs and basic soils design assumptions shall be shown on the drawings.
>
> . . . .
>
> 19. SERVICES DURING CONSTRUCTION (TITLE II) (OPTIONAL). Upon receipt of a modification exercising the option, the A-E shall proceed with the following . . . services:
>
> a. Checking of Shop Drawings . . . submitted by the Construction Contractor . . . .
>
> b. Engineering and Design During Construction. . . . including: visits to the site, preparation of modifications to the plans and specifications for user-requested changes and changed field conditions . . . .
>
> . . . .
>
> 21. A-E RESPONSIBILITY.
>
> a. This contract will remain in force until construction of the project has been completed. During this period, the A-E will be responsible for the correction of any design errors or deficiencies and liable to the Government as a result of A-E negligence, pursuant to the . . . Contract Clause [en]titled "RESPONSIBILITY OF THE ARCHITECT-ENGINEER CONTRACTOR" . . . .
>
> . . . .

A-E GENERAL DESIGN GUIDANCE
CONTROLLING CRITERIA

. . . .

2. STRUCTURAL . . .

b. Selection of Structural System. The overall structural system to be used will be based on the cost effectiveness of the system and will take into account both the superstructure and foundation. . . .

The A-E's 35% "design analysis" was to include "[f]oundation design data or assumptions and description of type of foundation system to be used." (R4, tab 5 at 1, 7, 9, 11, 14-18, 28-29, 51)

3. The A-E contract included the following FAR clauses:

52.236-22 DESIGN WITHIN FUNDING LIMITATIONS (APR 1984)

(a) The Contractor shall accomplish the design services required under this contract so as to permit the award of a contract, using standard [FAR] procedures for the construction of the facilities designed at a price that does not exceed the estimated construction contract price . . . .

. . . .

52.236-23 RESPONSIBILITY OF THE ARCHITECT-ENGINEER CONTRACTOR (APR 1984)

(a) The Contractor shall be responsible for the professional quality, technical accuracy, and the coordination of all designs, drawings, specifications, and other services furnished by the Contractor under this contract. The Contractor shall, without additional compensation, correct or revise any errors or deficiencies in its designs, drawings, specifications, and other services.

(b) Neither the Government's review, approval or acceptance of, nor payment for, the services required under this contract shall be construed to operate as a waiver of any rights

> under this contract or of any cause of action arising out of the performance of this contract, and the Contractor shall be and remain liable to the Government in accordance with applicable law for all damages to the Government caused by the Contractor's negligent performance of any of the services furnished under this contract. . . .

(R4, tab 5 at 138-39)

4. Harland Bartholomew & Associates, Inc. (HBA) and Engineering Science, Inc. (ESI) were affiliates of PMI (ex. G-85 at 2, ex. G-86 at 7). At the time the A-E contract was awarded, the COE was considering three sites for the NIMA facility, including a "Richardson Road" site about 50 miles southwest of St. Louis. The COE had separately contracted with HBA, which subcontracted with Shannon & Wilson, Inc. (S&W), to perform geotechnical investigations at the three sites. (R4, tab 6b at 5; tr. 59-62)

5. S&W's 18 May 1994 "Preliminary Geotechnical Investigation" submitted to ESI stated that at the Richardson Road site:

> . . . Bedrock consists of limestones and shales. The weathering zone extends several feet into the limestone. Weathering may have resulted in a pinnacled surface that could be substantially shallower or deeper than indicated by [our five soil] borings. . . .
>
> Foundation support could be derived from shallow footings bearing on rock or soil. Differential settlement between the transition from soil to rock may be a problem. . . . Deep foundations may be difficult and costly to construct due to irregular rock surface left by weathering and pinnacling of the rock surface and the presence of stringers and ledges. . . .
>
> . . . Footings at the . . . Richardson Road site . . . will have to transition from bearing on or near rock in deep cuts to bearing on compressible soil fills. . . . At . . . Richardson, a combination of shallow footings bearing on rock and piers of 10 to 30 feet in length could be used.

(Ex. G-87 at 1, 14-18)

6. On 19 July 1994, bilateral Modification No. P00002 to the A-E contract added a "geotechnical subsurface exploration for the Richardson Road site" in accordance with a "Scope of Work" that depicted the proposed building's footprint and required PMI to: (a) investigate subsurface conditions "by drilling approximately 60 test borings . . . spaced at

about 100-foot intervals and . . . extended to auger refusal," of which 40 were to be within the building footprint, 15 of which were to be extended 5-10 feet into rock and two were to be extended 25 feet into rock to provide information for deep foundation design, and by obtaining about 60 representative, relatively undisturbed core samples of cohesive soils at selected depths; (b) conduct laboratory analysis and visual classification of the soil samples; (c) submit to the COE a formal report evaluating the data collected in the subsurface and laboratory investigations and recommending the foundation type or types for construction; (d) prepare a "drilling plan" that addressed the identification of competent bedrock surface, potential pinnacled surface and open joints, weathered bedrock, potential for karst[2] features and identification of feature surfaces, and core sampling 25 feet into competent bedrock in at least two locations within the footprint of the facility; and (e) submit for Government approval the actual drilling assignment showing the minimum acceptable sample recovery (R4, tab 6a).

7. On 28 July 1994, ESI sent to the COE for approval a "Boring Layout Plan" with 70 borings, prepared jointly by PMI, ESI, and NIMA engineers (AR4, tab 508; tr. 876). On 26 August 1994, EMI sent the COE a 70-hole "Drilling Assignment," and on 29 August 1994, the COE recommended revising two borings (AR4, tabs 516-18; tr. 1317).

8. On 2 September 1994, ESI subcontracted with Burlington Environmental, Inc. (Burlington), re-named Philip Environmental Services Corp. (Philip) in April 1995, for geotechnical subsurface exploration to obtain information for the foundation design at the Richardson Road NIMA site (AR4, tab 519 at 1-3, tab 553; tr. 871-72, 874).

9. Burlington's subcontract required it to drill 70 test borings, 48 of which were to be in the building footprint and extended to auger refusal, two were to be "extended 25 feet into competent bedrock" and 18 were to be "extended 5 to 10 feet into rock"; to obtain 70 core boring samples; to submit to ESI for COE review and approval a "Drilling Assignment" and "Boring Layout Plan" with boring locations and depths, sampling methods and intervals, and minimum sample recovery; to identify competent bedrock surface, potential pinnacled surface, open joints, weathered bedrock, and potential for karst features and surfaces; and to provide "adequate deep foundation design recommendations." The subcontract's "Boring Layout Plan" showed 70 test boring locations. (AR4, tab 519 at 3-6, 9; tr. 882)

10. Bilateral A-E contract Modification No. P00004, first executed 21 September 1994, increased the number of A-E test borings from 60 to 70 (R4, tab 6c).

11. From to 3 September to 4 October 1994 Burlington prepared "Driller's Logs" and analyzed core boring samples for approximately 70 test borings drilled at the NIMA site, prepared foundation design calculations, and discussed the karst site geology with state officials (AR4, tabs 522, 524, 527; tr. 918-19). Burlington sent preliminary boring logs for COE review on 19 October 1994 (AR4, tab 528).

12. Burlington's 31 October 1994 "Geotechnical Study" was intended to obtain sufficient information on the NIMA site to make recommendations to PMI on the feasibility of shallow spread footing foundations and to estimate foundation settlement. Burlington confirmed that the site bedrock was limestone susceptible to "karst activity"--the "solutioning" of limestone bedrock by chemical reactions between rock and water along joints and bedding planes "resulting in an irregular, pinnacled bedrock surface." The bedrock depth was about 5 to 23 feet, measured from the surface to the point of auger refusal. Based on 100 kip (kip = 1,000 lbs.) building column loads, Burlington assumed that shallow foundations with spread footing or drilled shafts were appropriate, stating:

> The available [side] frictional component will be a small percentage of the total allowable load capacity of the drilled shafts because of relatively short lengths . . . . For simplicity in design, the frictional component could be ignored, and the drilled shafts should be designed as end-bearing shafts.

Shortly before that report, ESI had revised the building column loads to 520 kips and its grading plan showed up to 26 feet of fill, prompting Burlington's concern about differential settlement of footings spanning bedrock and fill, and the need to consider deep foundations. Burlington recommended additional field exploration to assess the extent of voids in the bedrock, and stated that if ESI elected "drilled shafts as a foundation alternative, a thorough analysis should be performed to assess the impact of Karst geology, allowable end bearing and shaft friction for design, acceptance criteria for the condition of the shaft base and [probe] holes, and any special construction recommendations." Burlington's report did not reflect subsurface conditions between or below the 70 borings. (Ex. G-104 at 1, 4-8, 15-20, 36)

13. The COE reviewed Burlington's Geotechnical Report for consistency of subsurface soils information with foundation design recommendations (tr. 419). The November 1994 comments of COE geologist Steven Jirousek on Burlington's Geotechnical Study included:

> The . . . weathered rock zones, fractured zones, zones of possible voids, thin bedding, and . . . clay seams suggest an overall poor quality rock mass with relatively low bearing capacities. Over-excavation of weathered rock may be necessary to significant depths. Suggest examination of all available subsurface data to . . . attempt more specific determination of top of competent rock elevations for design and construction purposes. . . . If deep foundation are [sic] to be included as a possible foundation alternative, then additional coring will be needed to properly identify the top of competent

> foundation rock and . . . fractured zones below the bases of the proposed pier. . . .
>
> Designers . . . need to provide a recommended bearing surface for the piers. . . . Based on the above shallow foundation comments it appears that deep foundations will support this project. . . . [I] recommend geotechnical designers review the publication "Foundations on fissured limestone – how they were selected", [ASCE] September 1965. This article provides excellent design considerations applicable to this project. . . .

(AR4, tab 531)

14. PMI's 25 November 1994 35% concept design proposed spread-footing foundations on the upper level and a mat foundation on the lower level (ASBCA 51717, R4, tab 25 at 1). Scott Loehr, COE's geotechnical engineer, commented on PMI's foundation design in December 1994:

> Additional subsurface investigation are [sic] warranted to determine the most practical yet competent foundation for this facility. I find it hard to believe that shallow and mat foundations would be more economical than deep foundation drilled piers to competent bedrock for this job. After supplemental subsurface investigation is completed, suggest a cost comparison [be] provided to justify the use of the mat and spread footing foundations.

(AR4, tab 532)

15. On 17 January 1995, Mr. Loehr told Burlington that it was important to perform additional drillings 25' into competent bedrock due to reported voids and fissures in the limestone; he was concerned about differential settlement if a foundation bore on bedrock and fill; the COE's philosophy was not to place a structure on fill and bedrock; and the COE would recommend placing all foundations on bedrock, but Burlington needed to provide supporting tests and analysis. The COE provided PMI the September 1965 ASCE article which compared, *inter alia*, end-bearing piers in sound bedrock, concrete mat, and "Piers into rock with, in fissured zones, multiple vertical rock sockets drilled 20-ft beneath the base of a pier, and concreted to provide both frictional and end-bearing support." (Ex. G-107; tr. 438-40).

16. Bilateral A-E contract Modification No. P00011, of 31 January 1995, required PMI to revise the 35% design because a NIMA requirement change reduced the building's square footage (R4, tab 6d). Bilateral Modification No. P00012, of 22 February 1995, added geotechnical services, test borings, core samples, and analyses of the feasibility of

using shallow spread-footing, mat, or drilled shaft foundations, and the estimated settlement of foundations and of the deepest planned fill (R4, tab 6e).

17. On 28 February 1995, bilateral Modification No. P00013 exercised COE's "Final Design" option for the NIMA facility and increased the construction contract cost limit to $39,345,000 (51355, R4, tab 6f).

18. Philip's 19 April 1995 "Revised Geotechnical Study," submitted to PMI contemplated a 187,300 square foot facility, of which 54,000 square feet were for a three-story office building, and 133,300 square feet were for a single-story warehouse and printing production building. Philip compared and analyzed shallow and drilled shaft building foundations, and stated that spread footing settlement might exceed what was considered structurally or architecturally acceptable, the need to deepen shaft excavations to avoid unacceptable bedrock could increase the cost of rock coring and require schedule adjustments, and:

> [D]rilled shafts bearing on sound bedrock can be designed for an allowable bearing pressure of 50 kips per square foot (ksf) . . . . Because of the variable depth to bedrock and potential for short shafts, the available [side] frictional components of the overlying soil could be a small percentage of the total allowable load of the drilled shaft. Therefore, the [side] frictional component should be ignored for end-bearing shafts. . . . Excessively weathered or highly fractured rock at the bedrock surface is not considered suitable for support of the drilled shafts and should be removed. It is anticipated that the . . . weathered rock at the bedrock surface could range from a few inches to several feet. The . . . irregular bedrock surface, unpredictable depth, thickness, and number of clay seams and zones of weathered, fractured bedrock make assigning an elevation or depth to intact bedrock an impossibility. [Thus,] a probe hole should be drilled at the base of each shaft to assess the condition and competence of the underlying rock . . . to a depth of two shaft diameters below the base. A feeler gauge should be used to check for the presence of clay seams and other discontinuities in the rock mass. . . . [Philip recommended discontinuity criteria to determine "sound limestone," and stated:] If discontinuities in excess of the above criteria are detected, the shaft excavation should be extended into the bedrock beyond the unacceptable discontinuities, and another probe hole should be drilled. The process should be continued until the acceptance criteria are satisfied or until the bedrock socket has been deepened by a

> sufficient length so that side friction will provide support *rather than* end bearing. [Italics added]

Philip drilled 16 test borings below auger refusal within the contemplated NIMA facility's footprint. Eleven of those 16 borings were drilled at least two pier diameters below auger refusal. For these 11, Philip's boring logs showed limestone with no discontinuities spaced less than 12" or having apertures exceeding one foot with soil or rock debris. Philip identified no side friction value or formula for acceptable pier support. Philip recommended that PMI retain Philip to observe all drilled shaft excavations prior to placing concrete. (AR4, tab 557 at 4, 31-32, 50; tr. 956-57, 1078) The COE reviewed and had no comments on or objections to Philips's Revised Geotechnical Study (tr. 453-54, 1323-24).

19. PMI's 16 May 1995 65% submittal to the COE for review under the A-E contract stated that shallow spread footing foundations could result in unacceptable differential settlement up to two inches, whose correction would extend the construction schedule. Thus, PMI selected 3½', 4' and 5' diameter, drilled shaft foundations bearing on "sound bedrock," stated that drilled shafts were likely to be more costly than spread footings, and said it would perform a cost comparison between spread footings and drilled shafts. (AR4, tab 561)

20. PMI's 19 June 1995 facility construction cost estimate, which PMI did not provide to the COE, included $2,214,000 for spread footing (AR4, tab 566) or $1,897,633 for drilled shaft foundations, *i.e.*, $316,367 more for the spread footing (tr. 1198-1201).

21. The COE's 4 October 1995 comments on PMI's 95% A-E design, including draft specifications and drawings, noted the need to define criteria for competent rock, to prepare a "Top of Competent Rock" contour map for estimating pier lengths, excavation depths and quantities of excavated materials, and to compare such top of competent rock contour with existing auger refusal data (AR4, tab 570). PMI's Project Manager, Nicholas Mariani, told the COE that specifying definitive pier elevation data was risky and difficult, but the COE told PMI that such data were necessary (tr. 1480-82).

22. William Bodtman, PMI's self-described "geotechnical engineer," testified that he suggested to an unidentified COE person that, to get more certainty about pier lengths, PMI should drill an exploratory boring at each pier location, but the COE rejected his suggestion as too expensive (tr. 1387-88). Such testimony conflicted with Mr. Bodtman's pre-trial deposition in which he said that he had not so suggested and did not know who did (tr. 1155-56, 1388, 1398). He explained that after the deposition, in a conversation with PMI's structural engineer Cecilia Hsiung, he recalled that he made the suggestion (tr. 1398-99). Ms. Hsiung did not testify. There is no evidence to substantiate such interpretation (tr. 895-96, 1154, 1355-56, 1543-44). The COE's Steven Jirousek said that at about the time of PMI's 95% design submission, the COE discussed a test boring at each pier, but decided not to do so. Jirousek did not know if PMI or Philip participated in that

discussion. (Tr. 1351-55) We find that PMI did not suggest to the COE to drill an exploratory boring at every pier location.[3]

23. After reviewing and concurring in Philip's geotechnical reports and recommended end-bearing drilled pier foundation design, Mr. Bodtman drafted specification § 02383, "Drilled Foundation Caissons," from a COE guide specification for drilled piers. He also prepared a contour map of the "bottom of drilled piers" elevations by the following methodology: (1) He located 16 exploratory borings within or near the building footprint that cored into bedrock. (2) Based on those 16 borings, he estimated the elevation at which it appeared that the probe hole criteria could be satisfied, and wrote such elevation next to the boring location on the site plan (Drawings C-3.11 to C-3.14). (3) He drew contour lines of estimated drilled pier bottom elevations on the site plan. (4) He superimposed the foregoing site plan contour lines on the drilled pier location plans, and tabulated an estimated bottom elevation for each drilled pier. (5) He deepened the estimated bottom elevation for each pier subject to uplift by one pier diameter. (Tr. 1383, 1388-91) On 5 October 1995, PMI sent the COE that contour map (AR4, tab 571). On 6 October 1995, PMI sent the COE a "Drilled Pier Analysis" showing the elevations of the top, bottom and "est. sound rock" of 24 piers in column lines 4 and A (AR4, tab 572 at 4-5; tr. 1372-76).

24. Mr. Bodtman interpolated from his contour map the boring refusal elevations set forth in "Table 1" in specification § 02383. Mr. Bodtman assumed that material below the end of borings Nos. 20, 28, 30, 35 and 43 would satisfy the probe hole criteria of acceptable bedrock for two pier diameters beneath the pier base stated in Philip's 19 April 1995 Revised Geotechnical Study. (Tr. 1369, 1397-98, 1419-20, 1422-27, 1447, 1449; ex. G-212 at 3, 6-7). The COE did not know of Mr. Bodtman's foregoing assumption, but it had PMI's 1994-95 test boring data showing that boring Nos. 20, 28, 30, 35 and 43 did not extend 10 feet below auger refusal or "top of rock" elevations, and Nos. 10, 15A, 23, 24A, 32A, 37A, 38, 44A, 46A, 50A and 52 extended from 11 to 25.5 feet below auger refusal (ex. G-23). None of the 1994 test borings done with respect to the Burlington/Philip geotechnical reports coincided exactly with any of the contemplated pier locations for the NIMA facility. The closest test boring, B-21, was about one to two feet from pier location D-14. (Ex. G-231) We find that both parties knew of the difficulty and uncertainty in identifying the top of "competent" or "acceptable" bedrock for pier support (tr. 1326-28, 1385, 1389; ex. G-124).

25. The COE's 10 October 1995 comments on PMI's Drilled Pier Analysis stated that: (a) PMI should state the elevations of the top of ground surface, the top and bottom of piers, and the top of rock/auger refusal for each pier, and (b) assuming the "top of pier" elevation was 181 meters, as PMI indicated, COE calculated pier bottom elevations significantly deeper than PMI did, and questioned what were PMI's criteria (AR4, tab 572; tr. 1329-34). On 17 October 1995, PMI explained to the COE that PMI used 176.63 meters and other elevations for top of some piers, not 181 meters in all areas, which

accounted for the difference in pier lengths, and PMI determined the top of competent rock from cored hole drill logs, not from auger refusal elevations, whereupon the COE told PMI to "proceed" (AR4, tab 574; tr. 1335-38).

26. On 7 November 1995, PMI told the COE that all its design comments to PMI had been resolved, and "top of rock" elevations corresponded to the "boring refusal" elevations set forth in "Table 1" of specification § 02383 (AR4, tab 576 at 4). The COE determined not to refer to Philip's geotechnical reports in the contract specifications (tr. 1378). The COE determined that all its review comments had been incorporated in the specifications, and that PMI's building design was satisfactory (tr. 130, 133).

27. Specification § 02383 DRILLED FOUNDATION CAISSONS (PIERS), at the conclusion of PMI's design efforts, provided in pertinent part:

> 1.2 BASIS OF BID AND UNIT PRICES
>
> 1.2.1 Bids
>
> The bids shall be based on the number and total estimated linear footage of caissons, of each diameter, as indicated and specified. Estimated pier lengths are given in Table 1 . . . . Adjustment of the contract will be made should total linear footage of caissons of each diameter installed and approved be greater or less than the total length tabulated. . . .
>
> . . . .
>
> 1.2.2.2. Proof Test Holes
>
> Contract shall include 1 proof test hole at each caisson shown. The [CO] reserves the right to increase or decrease the number of proof test holes. Adjustment to the contract price will be made for each such increase or decrease by the amount bid for "Additional Proof Test Hole" or "Omitted Proof Test Hole."
>
> 1.2.3 Unit Prices
>
> 1.2.3.1 Additional Caisson Lengths
>
> Additional caisson lengths will be paid for at the contract unit price for "Additional Caisson Length" for each diameter of caisson installed as approved.
>
> 1.2.3.2 Omitted Caisson Lengths

The contract price will be reduced by the amount bid for "Omitted Caisson Length" for each diameter of caisson omitted as directed.

. . . .

2.1.4 Strength
Concrete strength shall be 28 MPa (4000 psi) at 28 days.

. . . .

3.1 PREPARATION

a. Excavate caissons of the specified diameter through the soil and weathered rock zones, and at least 150 mm (6 inches) into hard, sound limestone, as verified by a qualified geotechnical engineer and/or geologist [GE/G]. Piers shown on the drawings to be socketed shall be drilled at least 1 pier diameter into hard, sound limestone. . . .

Vertical seams, wider than 25 mm (1 inch), if observed at the excavated bearing surface, shall be cleaned out to a depth of 4 times their width and filled with shush grout. Joints wider than 100 mm (4 inches) shall be filled with dental concrete. If joint width exceeds 20 percent of the pier diameter, the excavation shall be carried deeper.

. . . .

g. Each caisson excavation will be inspected and approved by the [CO] prior to placing concrete. The Contractor shall retain the services of a qualified [GE/G] who shall probe the required proof test hole, paragraph PROOF TEST HOLES, at each caisson with a feeler gage to check for clay or shale seams. Approval will be based on the following criteria for allowable thicknesses of seams:

Depth Interval	Maximum Allowable Cumulative Seam Thicknesses
0 to 0.5 shaft diameters	0
0.5 to 1.0 shaft diameters	50 mm
1.0 to 2.0 shaft diameters	100 mm

If the criteria is [sic] exceeded, the shaft shall be extended deeper and probed again. This process shall be repeated until the criteria has [sic] been satisfied or until the bedrock socket has been deepened to a sufficient length so that side friction will provide support rather than end bearing, as approved by the [CO]. A record of all inspection with related construction changes in connection therewith, shall be kept by the Contractor.

. . . .

3.4 PROOF TEST HOLES

3.4 1 General

a. After excavation, proof test the soundness of the rock below each caisson bearing level by percussion or rotary core drilling one hole . . . .

b. Holes shall be 50.8 mm (2-inch) diameter and drilled . . . to a depth below the bearing level equal to twice the design caisson shaft diameter.

(Ex. G-23) PMI anticipated that ¶ 1.2 of § 02383 would help the negotiations of prices for variations from PMI's estimated pier lengths (tr. 1482). Specification § 02383 did not set forth any equation or criteria for CO approval of side friction pier support on the rationale that, if the need arose, the Philip inspector would provide the CO the side friction equation or criteria during construction (tr. 1078-81, 1381, 1414-15).

28. Table 1 of § 02383 stated the pier number, diameter, top elevation, existing grade elevation, boring refusal elevation, estimated pier bottom elevation, and estimated pier length for 249 piers, having 3½', 4' and 5' diameters. The average length of piers in Table 1 was 13.59 feet (2,085 + 349 + 950 ÷ 249). Table 1 contained two notes:

Note 1: Boring refusal elevations . . . in Table 1 were interpolated from contours shown on Drawings C-3.11 to C-3.14.

Note 2: Estimated bottom elevations . . . in Table 1 are based on borings which included coring into bedrock. The elevations represent the estimated depth at which it is believed the criteria specified . . . in [§] 02383 will be satisfied. Actual bottom elevations will be determined during the [pier] installation based on the criteria.

(Ex. G-23 at 1-2, 9-10, 13-14, 17; tr. 1381, 1414)

29. PMI's 19 February 1996 final construction cost estimate provided to the COE for the NIMA facility included $917,575 for spread footing or $1,071,771 for drilled shaft foundations, *i.e.*, $154,196 less for spread footings (ex. G-4 at 115-16). PMI did not explain why this foundation estimate differed from its June 1995 estimate.

30. The COE's 3 April 1996 solicitation to construct the NIMA facility incorporated the FAR 52.212-11 VARIATION IN ESTIMATED QUANTITY (APR 1984) (VEQ) clause (R4, tab 7b at 1; ex. G-22).

31. On 27 May 1996, Drilling Services Co. (DSC) asked COE Project Manager Craig Robillard where in the NIMA construction contract could bidders find the "unit prices" of additional and omitted proof test holes, caisson lengths, and casing to which specification § 02383, ¶¶ 1.2.2.2 - 1.2.3.5 referred. On 28 May 1996 Mr. Robillard, without consulting PMI, answered that "unit prices for these items do not exist" and:

> The unit price and estimated quantities given in the bid sheet are an estimate to get to the target elevation at top of competent bedrock. The target depth for each caisson is given in the table in section 02383. There is enough information given in the bidding documents for a reasonable bid to be developed to get to what is estimated to be the top of competent rock. Variations in the actual quantities to get to what is estimated to be the top of competent rock will be adjusted at the unit price established in the bid sheet . . . by a negotiated modification during construction.

(AR4, tab 584; tr. 332-39)

32. The seven prices bid on 30 May 1996 for line items 1-8 of the NIMA facility construction contract ranged from $33,472,216 to $35,793,000, and were within the A-E contract's construction contract cost limit (ex. G-20). On 7 June 1996, the COE awarded a $32,146,035 fixed price construction contract for the NIMA facility to FRU-CON Construction Corp. (FRU-CON) for line items 1-7, based on PMI's design prepared under the A-E contract (exs. G-21, -24).

33. FRU-CON retained S&W geologist Mark Hoffman to inspect foundation pier drillings at the NIMA site for compliance with the construction contract acceptance criteria (tr. 756-58, 816-19, 963-64; ex. G-23 at 02383-6 to -8). Philip's John Kottemann trained Mr. Hoffman and COE inspector Jesse Vance how to inspect and to verify the acceptability of pier excavations pursuant to specification § 02383 (tr. 753-54, 817-18, 820, 966-71).

34. To FRU-CON's 13 August 1996 inquiry: "If suitable rock is encountered at the given top elevation of a pier, what is the minimum length of the pier required?" the COE answered on 22 August 1996, for socketed piers FRU-CON was required to "drill 1 x pier diameter"; for piers with a "nominal 6 inch socket into sound rock," if the specified probe hole criteria were satisfied, the drilled pier was not required (AR4, tab 598).

35. On 19 August 1996, DSC, FRU-CON's subcontractor, began drilling pier excavations (AR4, tab 586; ex. G-146 at 1, ex. G-200 at 1; tr. 158). On about 25-26 August 1996, for the first time FRU-CON told the COE that on 23 August 1996 it had not found acceptable bedrock at the design depth, performed over-drilling, and asked about using side friction acceptance criteria (ex. G-146 at 6; tr. 158, 968-69).

36. On 28 August 1996, PMI subcontracted with Philip to inspect each of the approximately 250 drilled pier shafts at the NIMA site for 66 working days beginning 19 August to verify their conformance to specified requirements and good engineering practice (AR4, tab 603).

37. On 29 August 1996, FRU-CON advised the COE that the "top of rock" may be at elevations considerably higher than expected (ex. G-151). The COE's 5 September 1996 letter to FRU-CON stated that if pier depth variations did not balance out, it would make an equitable adjustment under the VEQ clause (ex. G-156).

38. Bilateral Modification Nos. P00019 and P00020 to the A-E contract, on 4 and 28 September 1996, respectively, exercised the option for Title II engineering design, shop drawing review and added geotechnical services by PMI (R4, tabs 6g, 6h).

39. On 10 September 1996, the COE received Philip's 3 September 1996 side friction equations. On 11 September 1996, Philip sent PMI side friction support calculations, dated 28 August 1996, of "Lrock" (defined as "total length of intact limestone") for 3½', 4' and 5' diameter piers when soil and weathered rock (SWR) were less than, and exceeded, 5' plus one pier diameter. Philip's equations completely ignored end-bearing, "which is a conservation [sic] assumption." (AR4, tab 612)

40. On 12 September 1996, Mr. Vance provided Philip's 3 September 1996 side friction equations to FRU-CON (AR4, tab 613). FRU-CON's 13 and 19 September 1996 letters to the COE stated that those side friction equations were a "changed condition and/or a design change" (AR4, tab 617; ex. G-166). The COE's 18 September 1996 letter notified PMI that Philip's 3 September 1996 side friction equations erred because they used 3,000 psi rather than the specified 4,000 psi concrete design strength (ex. G-164; tr. 172-73).

41. On 17 September 1996, the COE received Philip's 16 September 1996 revised side resistance value of 6,480 pounds (6.48 kips) per square foot (KSF) and minimum

lengths of "Lrock," redefined as "intact limestone or sandstone that is free of clay or shale seams, and free of zones containing fractured or soft friable rock," of 6.8', 7.8' and 9.6' for 3.5', 4' or 5' piers, respectively, when SWR was less than, and three "Lrock" equations for said pier sizes when SWR exceeded, 5' plus one pier diameter (ex. G-162).

42. On 20 September 1996, Mr. Loehr told Philip of a projected $1 million cost overrun for piers, and, without PMI's review or recommendation, Philip "approved [the] use" of a 6.4 KSF side friction criterion for "massive limestone" below 25' depth (AR4, tab 609 at 5; tr. 317-18). On 23 September 1996, Philip revised that criterion to 6.48 KSF for the surface area of a pier "socketed into intact limestone" (AR4, tab 623).

43. On 17 and 24 September 1996, Philip told the COE that Philip believed that DSC was drilling to the design depth before inspecting for competent rock (AR4, tab 619). On the piers that Philip asserted DSC had "overdrilled" (Nos. 159, 167, 151 and 183S), Messrs. Hoffman of S&W and Kottemann of Philip both consistently reported zones and seams of shale and of clay interspersed with beds of weathered or intact limestone (ex. G-153 at 40, 42, 45, 48; AR4, tab 659 at 2-4, 6). DSC's foreman, Robert Rethemeyer, testified that DSC drilled to the planned depth when it did not hit any good material that would cause it to stop drilling (tr. 1299). The record contains no evidence that, before S&W inspected for seam compliance, DSC drilled through sound limestone of the number of shaft diameters required by specification § 02383, or through intact limestone or sandstone free of clay or shale seams, and of zones containing fractured or soft friable rock, criteria suggested by Philip (see finding 50).

44. The COE's 23 September 1996 letter to PMI said that, to date, the 3.5' piers exceeded design length by 73%, the 4' by 84%, and the 5' by 136%; the COE was concerned about a cost overrun, because at the rate DSC was drilling below design depth, Government funds would be exhausted before the NIMA facility could be completed; and the COE needed corrected side friction equations (exs. G-168, -170; tr. 138-40, 173-74).

45. On 25 September 1996, Philip approved pier No. 118S by side friction criteria (ex. G-146 at 47). From 1 October 1996 to 16 February 1997 13 piers were accepted by Philip's side friction criteria, including eight piers after Mr. Kottemann left Philip (ex. G-153 at 40, 42, 45-46, 48-49, 52-54, 62, 81, 102).

46. On 30 September 1996, PMI sent the COE Philip's 24 September 1996 letter recommending relaxed probe hole seam criteria, and re-revised side friction equations corrected for 4,000 psi concrete (ASBCA 51717, R4, tab 81; tr. 1071-73).

47. On 8 November 1996, the COE expressed concern to PMI about a FRU-CON differing site condition claim due to over-drilling piers (ex. G-177). On 18 November 1996, FRU-CON advised the COE that installing 249 piers as designed would require an estimated additional $4.7 million (ex. G-180).

48. In December 1996, the COE learned that, due to an anticipated NIMA mission change, the facility could be reduced by 60,000 square feet. That mission change did not require any alteration of the type of foundations. The COE orally asked PMI to redesign a smaller facility, to eliminate the design structural loads anticipated for a future increase in the number of floors in certain areas of the facility to accommodate other federal agencies, and to change the remaining foundation from drilled piers to shallow, spread footings. (Tr. 223-26, 228, 230-32, 355; ex. G-197)

49. Unilateral Modification No. P00022 to the A-E contract, executed 21 November 1996, required PMI for 15 working days to observe the acceptability of bedrock sockets, bearing surfaces and probe holes for drilled shaft foundations "based on geologic and engineering judgement, not just strict interpretation of the specifications," and to "assess side friction . . . between soils and rock . . . applying the formulas for estimating side resistance, when necessary" (51355, R4, tab 6i).

50. DSC drilled 104 piers for the NIMA facility, installing 4 piers (Nos. 106, 107, 113, and 157) at elevations *above*, and 100 piers at elevations *below*, the "Estimated Bottom Elev[ation]" (EBE) stated in Table 1 of specification § 02383. Despite testimony about drilling to the design elevation without inspecting seam compliance (tr. 470; 51717, R4, tab 75), S&W' s daily logs and "Drilled Pier Inspection Reports" (DPIR) show that it: (a) inspected 61 piers for end-bearing seam compliance at elevations at or *above* the EBE; (b) inspected 32 piers for end-bearing seam compliance at elevations *below* the EBE, 8 of which (Nos. 103, 109, 119, 132, 140, 145, 168, 192) it inspected at elevations *above*, and 24 *below*, its measured "top of rock"; and (c) accepted 14 piers (Nos. 118S, 124, 139, 151, 152, 159, 167, 175, 180S, 183S, 188S, 201S, 231, 256) pursuant to side friction criteria, three of which (Nos. 118S, 139, 167) it inspected for end-bearing seam compliance. Of the 24 piers DSC drilled below the EBE and S&W's measured "top of rock" before inspecting for end-bearing seam compliance, DSC drilled 22 piers further to reach compliant rock. (Exs. G-146 at 3, 12-13, 16, 24, 26, 33-35, 37-38, 44-45, 49, 53, 62, 70, 85, 92, 104, 106, 116, 118, 128, 132, 134-35, 141, 145, 157, 160, 167, ex. G-153)

51. On 11-12 February 1997, COE, NIMA and PMI representatives agreed to a 61,100 square foot reduction in the NIMA facility footprint due to reassignment of certain storage, distribution, shipping and receiving functions from NIMA to Defense Logistics Agency (ex. G-197).

52. On 25 February 1997, the CO directed FRU-CON temporarily to stop the structural steel work on part of the NIMA facility where the building footprint was to be reduced (ex. G-26).

53. On 5 March 1997, the CO issued unilateral Modification No. P00005 to the construction contract, directing FRU-CON to construct the NIMA facility as redesigned to reduce the building's footprint, delete certain drilled piers and add shallow spread footing foundations (ex. G-27).

54. PMI substantially performed the NIMA facility redesign by March 1997, and on 22 April 1997 PMI submitted to the COE a detailed proposal for the redesign services, including reviewing redesigned shop drawings and responding to FRU-CON's requests for information (ASBCA 51717, compl. & answer., ¶ 17; tr. 1306-07).

55. On or about 27 March 1997, the COE released revised foundation and underground plumbing redesign drawings to FRU-CON with notice to proceed with such changes (AR4, tab 683). On 28 April 1997, FRU-CON and the CO agreed upon Modification No. P10005 to the construction contract, which lifted the CO's partial stop work order, provided revised structural steel fabrication drawings, and promised to release revised building construction drawings (ex. G-28).

56. On 22 May 1997, the CO issued Modification No. P00024 to the A-E contract to confirm the CO's December 1996 verbal direction to redesign the NIMA facility (ASBCA 51717, comp. & ans., ¶ 18). $86,500 obligated for PMI's redesign services by A-E contract Modification No. P00024, was de-obligated by Modification No. P00030. Respondent has refused to pay such amount, because the CO determined that such redesign was the result of PMI's negligence. (ASBCA 51717, comp. & ans., ¶ 20)

57. On 19 September 1997, bilateral Modification No. P00009 to the construction contract increased the contract price by $855,592–

> due to incorrect top of rock elevation listed in the contract and the condition or quality of rock that was used to calculate for the pier length. This differing site condition resulted in drilling most of the piers through a greater length of rock than could have been reasonably anticipated and resulted in [pier] placement to lengths beyond the 15% allowed under the terms of the contract.

(Ex. G-29 at 2)

58. On 26 November 1997, the CO issued a final decision alleging that PMI had made negligent errors in the subsurface site investigation and pier design for the NIMA facility foundation under the A-E contract, and claiming $8,733,427 damages therefor (R4, tab 3). PMI timely appealed therefrom on 19 February 1998.

59. On 22 May 1998, PMI requested a CO's final decision on its claims for the costs associated with (a) the redesign of the NIMA facility, including the foundation ($369,939); (b) the preparation of required shop drawings for such redesign ($85,673); and (c) PMI' s engineering services during the construction phase, namely responses to requests for information from the COE and FRU-CON ($90,340). PMI's claims for the redesign work totaled $545,952. (51717, comp. & ans., ¶ 21; R4, tab 5)

60. On 19 August 1998, the CO issued her final decision denying PMI's 22 May 1998 claim in its entirety on the basis that PMI had committed "negligent errors in the design of the NIMA facility foundation" (51717, comp. & ans., ¶ 22; R4, tab 3). PMI timely appealed therefrom on 28 August 1998 (51717, comp. & ans., ¶ 23; R4, tab 2).

61. Dr. Fred H. Kulhawy has approximately 37 years experience in consulting and teaching in soil and rock mechanics, foundation engineering and engineering geology, and he participated in the ASCE "Drilled Shaft Standard (1992-95)" (ex. G-76 at 1-6). We find that Dr. Kulhawy has expertise in the standards of geotechnical engineering. He was accepted as the COE's expert in geotechnical engineering, drilled piers in rock, and Osterberg load testing (tr. 490). He reviewed PMI's facility design contract work scopes, geotechnical studies, rock core photographs, designs and specifications, PMI-COE correspondence and briefing slides, drilled pier logs, and geological and foundation technical publications (ex. G-229 at 34).

62. Dr. Kulhawy opined that a "foundation designer with at least average ability, exercising reasonable skill, care, and diligence, would not have produced a design with the [following] aggregate shortcomings":

> 1. The designer [PMI] did not characterize the site in sufficient detail to understand the rock mass conditions fully. All borings (at least near the structure) should have gone to refusal, and all within and near the structure footprint should have cored rock.
>
> 2. The foundation type selected by the designer may not have been the most optimal or economic. A spread footing may have been more appropriate for this structure at this site.
>
> 3. The rock mass characterization by the designer inappropriately assumed that good quality rock would be obtained at shallow depth beneath the rock surface.
>
> 4. This rock mass characterization was overly optimistic, which in turn resulted in drilled shafts designed for tip resistance only.
>
> 5. The tip resistance design was very conservative and contained errors.
>
> 6. The designer's field acceptance criteria were very stringent and were not based on specific project or site issues. It was very difficult to achieve these criteria in the field.

> 7. The side resistance alternative provided for in the specifications was not given by the designer and, for all practical purposes, did not really exist.
>
> 8. The side resistance design, when finally done by the designer, was very conservative and contained errors.
>
> 9. When field problems arose within weeks of beginning shaft construction, effective remedies or contingencies did not exist to solve the problems. Potential solutions had to be developed by the designer while shaft construction continued, but they were ineffective in resolving the overdrilling of shafts that was occurring in the field.
>
> 10. Throughout all project documents, definitions of rock and its quality never existed, so all rock issues were subject to individual interpretation.

(Ex. G-229 at v) Dr. Kulhawy said that any one of the foregoing "shortcomings" may not have created a design problem, but their aggregate created design problems (tr. 662-63).

63. Dr. Kulhawy opined that PMI's "tip-resistance design" equation apparently was taken from a 1988 "FHWA Manual on Drilled Shafts," and its specific "error" was that it was "not directly applicable to the NIMA site geology" whose "karstic rock mass" did not meet the FHWA's criteria of discontinuities spaced at greater that 12" and with apertures less than 0.2" (or less than 1' if filled with soil or rock debris), and a foundation width greater than 12". Dr. Kulhawy did not substantiate the foregoing views by any PMI test boring data. (Ex. G-229 at 14). Philip drilled 16 test borings below auger refusal within the contemplated NIMA facility's footprint (ex. G-23). At the 11 deepest elevations of those 16 borings, Philip's boring logs showed limestone with no discontinuities spaced less than, or having apertures exceeding, one foot with soil or rock debris (see findings 18, 24). PMI's 3.5', 4' and 5' diameter piers all exceeded 12" (see findings 19, 28). Dr. Kulhawy agreed that a deep shaft foundation was a viable design choice (tr. 685).

64. Dr. Melvin I. Esrig was accepted as PMI's expert in geotechnical engineering and the standard of engineering practice for the geotechnical design of deep foundations, including drilled shaft foundations (tr. 1108-09). He reviewed the Burlington and Philip geotechnical reports and memoranda; PMI design submissions, plans and specifications for drilled piers; COE design review comments; pertinent correspondence; field records of drilled pier installation; technical articles; deposition transcripts and exhibits; and laboratory calculations, data and memoranda (AR4, tab 711 at 2, app. 1; tab 729 at 8).

65. Dr. Esrig opined that (a) PMI's subsurface investigation, including the quantity of test borings and their depths, and laboratory testing were "well within the boundaries of

the Standard of Practice in foundation engineering" considering "the natural variation in subsurface conditions" at the NIMA site; its site characterization was "complete, accurate and well within the standard of practice," and the expectation of variability in rock surface elevation was communicated several times to the COE (AR4, tab 711 at 7, 9, 11, tab 729 at 14-16, 20, 22-24); (b) PMI adequately compared shallow, mat and deep foundations and selected the deep foundation to avoid differential settlement of a shallow foundation on rock, backfill and natural soil, and the delay anticipated for settlement of backfill (AR4, tab 711 at 15, tab 729 at 25-26, 29-33); (c) the 50 ksf end-bearing only criterion, omitting side friction values, that PMI selected was compatible with the 43% "rock quality density" identified in the sub-surface exploration and with the specified empirical, acceptable seam criteria, was not overly conservative, and conformed to the standard of practice in the St. Louis area and was not negligent; and the 5 ksf to 10 ksf side friction values PMI recommended to the COE were within the standard of practice in the St. Louis area and were justified by test data and pier wall observations (AR4, tab 711 at 16-20, tab 729 at 35-38, 41-45, 47-50); (d) PMI's pier length estimating methodology was reasonable, considering the "severe limitations" imposed by the "variability in the depth to rock" and the differing site condition Fru-Con encountered resulted from bedrock variations exceeding those anticipated from PMI's subsurface explorations, not from PMI's design negligence, and FRU-CON's over-drilling resulted from its practice of drilling to the estimated pier bottom elevation before probing the proof test hole (AR4, tab 711 at 23, tab 729 at 52-53, 54-56, 61-63); and (e) PMI responded rapidly and correctly to modify the acceptance criteria for simultaneous end-bearing and side friction, in accordance with industry and St. Louis practice (AR4, tab 711 at 25-26, tab 729 at 64-65).

DECISION

I. ASBCA No. 51355

To prevail in a defective design claim under the FAR 52.236-23 RESPONSIBILITY OF THE ARCHITECT-ENGINEER CONTRACTOR clause, the Government has the burden of establishing three elements of proof: (1) Did the construction contractor substantially comply with the A-E's design in the manner intended by the A-E? (2) Did the A-E exercise its skill, ability and judgment negligently, instead of with reasonable care, with respect to the design? (3) Was the A-E's defective design the proximate cause of damage to the Government? *See Brunson Associates, Inc.*, ASBCA No. 41201, 94-2 BCA ¶ 26,936 at 134,152; *Ralph M. Parsons Co.*, ASBCA No. 24347, 85-1 BCA ¶ 17,787 at 88,901-02, *recon. denied*, 85-2 BCA ¶ 18,112; *Benjamin S. Notkin & Associates*, ASBCA No. 29336, 86-1 BCA ¶ 18,535 at 93,123 (Gov' t has burden of proof of negligent A-E design claim).

A.

PMI contends that FRU-CON did not comply with the construction contract because it excavated piers to the EBE stated in specification § 02383, Table 1, before inspecting for end-bearing seam compliance. Specification § 02383 did not state at what elevation the construction contractor was required to inspect pier excavations for compliance with the seam thickness criteria for "sound limestone" (finding 27). After 22 August 1996 FRU-CON knew that it did not have to excavate a pier if it encountered "suitable rock" at the pier's top elevation (finding 34).

The record contains no evidence that, before S&W inspected any pier excavation for seam compliance, DSC drilled through "sound limestone" or intact limestone or sandstone free of clay or shale seams, and of zones containing fractured or soft friable rock, criteria suggested by Philip (finding 43). Notwithstanding testimony about drilling to the design elevation without inspecting seam compliance, the record shows that S&W inspected 61 piers for seam compliance at elevations at or *above* the EBE, and 8 piers at elevations *above* S&W's measured "top of rock" elevations. DSC excavated 24 piers below the EBE and S&W's measured "top of rock" elevations before S&W inspected for seam compliance, and for 22 of those 24 piers, excavated further to reach compliant rock. (Finding 50) DSC's foreman (PMI's witness) testified credibly that DSC drilled to the planned depth when it did not hit any good material that would cause it to stop drilling (finding 43). We hold that FRU-CON substantially complied with the construction contract's requirements for inspecting pier excavations for end-bearing seam compliance.

B.

PMI argues that the Government must prove that PMI did not meet "the standard of engineering practice adopted by practicing geotechnical engineers in the St. Louis area." (App. reply br. at 95-96) On the basis of our research, no ASBCA decision has so held, nor do the decisions PMI cites. In *Clovis Heimsath and Associates*, NASA BCA No. 180-1, 83-1 BCA ¶ 16,133 at 80,129, the Government argued that A-E practice in the Houston locality was the standard of skill and ability, but the Board did not apply such a standard. In *Leo A. Daly Co.*, ENG BCA No. 4403, 85-1 BCA ¶ 17,740 at 88,591-92, there is *dictum* that "the architect ordinarily, by his contract with the owner, undertakes to comply at least with the standards of practice employed by average local architects," but that decision discussed no evidence of average local A-E standards of practice, and applied instead the requirements of the American Concrete Institute Codes incorporated in the contract. In *Lenz GmbH Architect-Engineer*, ASBCA No. 36819, 90-3 BCA ¶ 23,220 at 116,531, we applied the national standard of skill and ability of a "reasonable, prudent West German architect." In *Norair Engineering Corp.*, ENG BCA No. 5244-Q, 98-2 BCA ¶ 29,967 at 148,269, the Board applied a national standard of care in a Government claim against a construction contractor, not an A-E. We reject the local area standard of skill, ability and judgment advanced by appellant.

PMI argues further that Dr. Kulhawy, the Government's expert witness, was not represented to be, or accepted as, an expert in the national or St. Louis local standard of geotechnical engineering practice, and so his opinions must be disregarded (app. reply br. at 103-04). Dr. Kulhawy has approximately 37 years experience in consulting and teaching in soil and rock mechanics, foundation engineering and engineering geology, and he participated in the ASCE "Drilled Shaft Standard (1992-95)." We found that Dr. Kulhawy has expertise in the standards of geotechnical engineering, and accepted Dr. Kulhawy as an expert in geotechnical engineering. (Finding 61) We reject the argument that Dr. Kulhawy's opinions must be disregarded. We evaluate his opinions to determine the extent to which they are supported by evidence in the record.

Dr. Kulhawy opined that PMI's 1994-95 geotechnical subsurface explorations did not characterize the site in sufficient detail and its test borings should have gone deeper (finding 62(1)). PMI's geotechnical explorations, including the number, intervals and depths of its test borings, were reasonable and complied with the COE's requirements specified in the A-E contract Modification Nos. P00002, P00010, P00011 and P00012 (findings 6, 9-12, 16). Such explorations were not negligently performed.

Dr. Kulhawy opined that the deep-drilled pier foundation design PMI selected may not have been the "most optimal or economic" and the spread footing foundation may have been more appropriate for the NIMA site (finding 62(2)). That opinion is not supported by the record facts. In February 1996, PMI provided to the COE an estimate that spread footings would cost $154,196 less than deep drilled foundations (finding 29). Such cost comparison was plainly subordinate to the structural and geotechnical reasons for selecting the deep drilled shaft foundation, namely, to avoid differential settlement of a shallow foundation on footings spanning bedrock and fill, which was technically unacceptable to PMI, Philip and the COE (findings 12-16, 18-19). Moreover, Dr. Kulhawy agreed that a deep shaft foundation was a viable design choice (finding 63).

Dr. Kulhawy opined that PMI "inappropriately assumed" that good quality rock would be encountered "at a shallow depth beneath the rock surface," which assumption was "overly optimistic" (findings 62(3),(4)). PMI's test boring data included 11 borings in which it found competent bedrock 10 or more feet below auger refusal, and 5 test borings that did not so extend. Mr. Bodtman assumed that the material below those five borings would satisfy the probe-hole criteria for "sound limestone." The COE did not know of such assumption, but it had all PMI's test boring data and knew that Philip had estimated the pier bottom depths (EBEs) from test borings within the facility footprint, none of which coincided with the contemplated pier locations. Most critically, both parties were aware of the difficulty and uncertainty in identifying the elevation of the top of acceptable bedrock for pier support in pinnacled karst limestone, whose surface was highly variable within a short lateral distance. (Findings 5-6, 9, 12-13, 18, 21, 24-25) Considering that two-thirds of PMI's test borings that yielded the EBEs extended at least ten feet into competent bedrock, we conclude that PMI's assumption about acceptable bedrock was neither inappropriate nor overly optimistic.

Dr. Kulhawy opined that PMI's end-bearing pier design was "very conservative and contained errors" (finding 62(5)). That a design is "very conservative" does not show that such design was negligent. The design "error" Dr. Kulhawy asserted – using an equation apparently derived from a FHWA Manual without complying with the criteria prescribed for use of such equation – was not substantiated by any factual evidence. Indeed, Philip's test borings within the building footprint that extended below auger refusal, showed at their deepest elevations limestone with no discontinuities and within the spacing and aperture criteria specified in the FHWA Manual. (Finding 63)

Dr. Kulhawy opined that PMI's end-bearing pier acceptance criteria were "very stringent" and were "not based on specific . . . site issues" (finding 62(6)). Stringency of acceptance criteria does not establish that such design criteria were negligently selected. Such criteria plainly were tailored to the subsurface characteristics of the NIMA site. The appeal record shows that PMI selected the probe hole seam criteria specifically because it was impossible to determine accurately the top elevation of the pinnacled karst limestone bedrock at the NIMA site, and the COE was well aware of the rationale justifying those criteria (findings 18, 21, 23).

Dr. Kulhawy opined that PMI failed to provide a practical side friction alternative to the end-bearing pier acceptance criteria (finding 62(7)). The pier specification § 02383 that PMI drafted contained no equations or criteria for the CO to approve of side friction pier support, on the rationale that, if the need arose, the Philip inspector would provide the CO the equations or criteria during construction (finding 27). Dr. Esrig opined that the omission of side friction values and reliance on end-bearing only criteria was not negligent (finding 65(c)). The Board assesses the probative weight of the two experts' opinions to be equal. Thus, the preponderance of evidence does not support the COE's contention. PMI, through its subcontractor Philip, provided a side friction equation to the COE on 10 September 1996, 18 days after FRU-CON asked the COE for side friction acceptance criteria (findings 35, 39). By 25 September 1996 Philip approved the first pier by side friction criteria, and approved 13 more piers by side friction criteria thereafter (finding 45). PMI provided side friction criteria with reasonable promptitude when requested. They constituted a practical alternative to end-bearing seam inspection criteria.

Dr. Kulhawy opined that PMI's side friction criteria were "very conservative and contained errors" (finding 62(8)). Conservatism is no proof of negligence. Philip's 3 September 1996 side friction equations contained an error – 3,000 vs. 4,000 psi concrete strength - which Philip corrected 12 days after the COE pointed out that error (findings 40, 46). Such error did not delay using Philip's side friction equations to accept piers (finding 45). We conclude that such error did not prejudice FRU-CON or the COE.

Dr. Kulhawy further opined that PMI's side friction equations and acceptance criteria "were ineffective in resolving the overdrilling of shafts" (finding 62(9)). When FRU-CON requested use of side friction criteria to accept pier excavations, 14 piers were accepted (finding 45). That FRU-CON did not request side friction pier acceptance in more instances does not establish PMI's negligence.

Dr. Kulhawy opined that PMI did not define "rock and its quality" so suitable rock was "subject to individual interpretation" (finding 62(10)). Specification § 02383, as PMI drafted it, required the construction contractor to use a "qualified geotechnical engineer and/or geologist" to inspect each pier excavation for conformity to the specified, quantitative, clay or shale seam thicknesses (findings 18, 27). Philip instructed S&W's and the COE's inspectors how to perform such pier excavation inspections and to apply such acceptance criteria (finding 33). We conclude that PMI defined "hard, sound limestone" and provided acceptance criteria for pier excavations competently, not negligently.

Dr. Kulhawy stated that only in their aggregate would the 10 PMI foundation design shortcomings he asserted create problems (finding 62). Our review of his ten "shortcomings" shows that none of them is fully supported by the appeal record. Thus, we reject Dr. Kulhawy's conclusions and opinions on "design problems" and negligence. *See Craft Machine Works, Inc.*, ASBCA No. 47227, 97-1 BCA ¶ 28,651 at 143,121-22 (in findings 70-74, Board rejected both experts' opinions because of invalid premises and conflicts with documentary evidence); *Michigan Joint Sealing, Inc.*, ASBCA No 41477, 93-3 BCA ¶ 26,011 at 129,325, *aff'd*, 22 F.3d 1104 (Fed. Cir. 1994) (table) (expert opinion rejected because its assumption was contrary to contract terms).

Accordingly, we hold that respondent did not establish that PMI exercised its skill, ability and judgment negligently, rather than with reasonable care, with respect to the NIMA facility foundation design. In view of this holding, we do not analyze or decide whether PMI's foundation design was the proximate cause of damage to the Government.

We sustain the appeal in ASBCA No. 51355.

II. ASBCA No. 51717

In December 1996, the COE requested PMI to redesign the NIMA facility, to eliminate the design structural loads anticipated for a future increase in the number of floors in certain areas of the facility to accommodate other federal agencies, and to change the remaining foundation from drilled piers to shallow, spread footings (finding 48). PMI substantially performed the NIMA facility redesign by March 1997, and on 22 April 1997 PMI submitted to the COE a detailed proposal for the redesign services, including reviewing redesigned shop drawings and responding to FRU-CON's requests for information (finding 54). On 22 May 1997, the CO issued Modification No. P00024 to the A-E contract, confirming his verbal direction to redesign the NIMA facility (finding 56).

In light of our holding that the NIMA facility foundation redesign was not the result of PMI's negligence, we hold that PMI is entitled to compensation for its redesign services. We sustain the appeal in ASBCA No. 51717 and remand it for determination of quantum.

Dated: 10 June 2002

DAVID W. JAMES, JR.
Administrative Judge
Armed Services Board
of Contract Appeals

I concur

MARK N. STEMPLER
Administrative Judge
Acting Chairman
Armed Services Board
of Contract Appeals

I concur

EUNICE W. THOMAS
Administrative Judge
Vice Chairman
Armed Services Board
of Contract Appeals

NOTES

[1] Citations to Rule 4 documents are to ASBCA No. 51355, unless otherwise stated.

[2] WEBSTER'S 3D NEW INTERNATIONAL DICTIONARY, UNABRIDGED at 1233 (1986), defines "karst" as "a limestone region marked by sinks, abrupt ridges, irregular protuberant rocks, caverns, and underground streams."

[3] PMI's 26 April 2002 sur-reply brief seeks the Board to admit exhibit G-127 in evidence because PMI "inadvertently" objected "in error" to G-127. An inadvertent error about a known document is an invalid basis to reopen the record closed on 30 April 2001 to admit G-127. Furthermore, G-127 would not change our finding because it states that in a 5 October 1995 "Pre-meeting to call to A/E" the COE mentioned "test every hole as part of design to give some idea of pier depth," but does not state that the COE discussed such procedure with PMI or that PMI suggested that procedure.

I certify that the foregoing is a true copy of the Opinion and Decision of the Armed Services Board of Contract Appeals in ASBCA Nos. 51355 and 51717, Appeals of Parsons Main, Inc., rendered in conformance with the Board's Charter.

Dated:

EDWARD S. ADAMKEWICZ
Recorder, Armed Services
Board of Contract Appeals