

# **Engineering Ethics Cases with Numerical Problems**

from an NSF & Bovay Fund sponsored workshop

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Texas A&M University

**Electrical Engineering Case 9**

*Underbidding the Job*

: Suggested Courses:

Joseph Wujek Intro to Engineering

.berkeley.edu) Level

Freshman & Sophomore

## **I. Narrative**

You are a Project Engineer employed by Hotshot Engineers, Inc. (HEI). The company has just been selected, but the contract not yet signed, for doing the detail design and engineering and construction management for a new water supply system for the City of Cesspool, USA. The system will serve about 50 thousand residences. This is a turnkey job with an estimated constructed value of between \$10M - \$15M.

HEI profits for the preceding year were \$1.59M. It is likely that the City of Cesspool job is the only large (for HEI) job to be booked by the company in the current fiscal year (FY). About 80% of profits from the job are collectible in the current FY.

Your company and the competition each submitted a comprehensive proposal and sealed (secret) bid. The selection was based strictly on low bid and the proposed design meeting technical requirements. All bids are public record after opening. HEI bid \$12.88M. The two competitors' bids were: Company A at \$13.38M; Company B at \$14.11M. (Bids shown to only four significant figures.)

The events below occur after a public announcement of selection of HEI.

(a) In routinely going over the submitted proposal and drawings in preparation for a press conference, you and the Chief Engineer discover that an important part of the purification system has been underestimated in cost. This occurred because part of the preliminary design concept was done without adequate analysis. To construct as indicated by the bid HEI submitted would result in the output water not meeting EPA Regulations. To do it right (and meet EPA Standards) would add cost. A summary of the HEI costs/profit is tabulated below, showing the corrected values in <angle brackets>. (Figures are rounded for our convenience here.)

## Hotshot Engineers, Inc.

### Bid Summary: City of Cesspool Water Works Job

#### ITEM or Sums \$, Millions

Engineering & Management 0.910

Construction Materials 2.900 <3.200>

Construction Labor 5.600 <6.600>

Support, Overhead, etc. 0.360

Subcontractor Services 0.700

Performance Bonds, Insurance, etc. 0.500

Environmental Impact Study 0.200

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SUBTOTAL 11.17 <12.47>

Contingencies at 4.8% of subtotal 0.536 <0.599>

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TOTAL 11.71 <13.07>

Profit at 10.0% of total 1.17 <1.31>

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(Sum) **Submitted BID 12.88**

(Sum) **True (not submitted) BID <14.38>**

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## II. Numerical and Ethical Questions

Question 1. What is the net profit or loss in dollars to HEI to do the job right per the (erroneous) submitted bid?

Question 2. Based on the information above, what is your recommendation to your boss, the Chief Engineer?

Question 3. Suppose, independent of your answer in (a2), the Chief Engineer tells you: 'Let's keep this to ourselves. Once we get the job we'll slip in some change orders to get our true cost plus a reasonable profit. After all, we disclosed all they asked for in our submitted design. If they didn't catch it that's their problem. It's *caveat emptor* (let the buyer beware) in the good ol' USA!'

What is your response to the Chief Engineer?

Question 4. Now suppose that (3) did not occur but what was decided by HEI management to proceed normally until there is an opportunity to sort out matters. You attend a combined public hearing and press conference in the City Hall of Cesspool. You are part of a small panel of HEI engineers and managers asked to tell about the design and answer questions from the floor.

At the public meeting should you mention *voluntarily* the design shortcoming and associated costing error? Explain the rationale for your answer.

Question 5. Suppose a person in the audience asks the entire panel: "How was HEI able to underbid the competition? Your bid seems awfully low to me...but then I'm not an engineer." Nobody mentions the design shortcoming and cost error. What do you do?

Question 6. Suppose YOU are asked the question of part (5). State your response.

Question 7. Suppose the events in (5) and (6) did not occur, but now an engineer employed by one of the competitors underbid by HEI asks you: "How was HEI able to underbid the competition?" What do you do?

### III. Solutions to Numerical and Ethical Questions

1. The true estimated cost, including contingency, is \$13.07M. Subtracting this amount from the \$12.88M bid yields a net LOSS to HEI of \$0.190M. Although not all costs can be determined precisely, the variability cannot be assumed to work in favor of HEI. Therefore, it is highly probable that the company will suffer a loss for the fiscal year that could be ruinous, dependent upon corporate reserves, etc.

2. Withdrawing the bid appears the only alternative. Not enough information is given in the problem statement to discuss other options.

3. The Chief is proposing a variant of "low-balling," an unethical, and possibly illegal, practice. Evidently, low-balling was not a deliberate scheme in this case because an "honest" mistake occurred. However, "sloppy" engineering is evident, and this violates professional principles.

The Chief's proposed action is not permissible. If HEI accepts the Chief's scheme, the engineer is culpable and could be prosecuted in both criminal and civil courts. Of course the engineer is placed in an extremely difficult position, but he cannot agree to be a party to the scheme. If a P.E., the engineer could appeal to the state entity having jurisdiction over licensure. However, it may be very difficult (impossible?) to "prove" that the Chief advocated this action. If not resolvable inside HEI, the engineer may have to contact the client and disclose the mistake before the contract is signed. As Project Engineer, the engineer would be acting within the scope of the job, and more importantly, would be acting professionally, i.e. ethically.

4. Because HEI has not yet had opportunity to discuss the error it is arguable that voluntary disclosure is not appropriate. No contract has been executed.

5. Again, voluntary disclosure would be premature and unwarranted.

6. and 7. Consider responding, "Until we have had a chance to discuss our bid and compare it to the

competitor's bids, it would be inappropriate to comment. Is this a deception?