

University of Arkansas Microelectronics-Photonics Graduate Program

PhD Candidacy Exam – March 2008

Photonics Area of Emphasis Exam

PROBLEM TO BE SOLVED

You are the CTO of a company that specializes in environmental monitoring of emissions from coal-fired power plants. You have been given the task of developing a portable laser-based system that can remotely analyze the gas coming out of the stack for CO₂, CO, SO₂ and various nitrogen oxides. The laser transmitter and the receiver do not have to be in the same place.

This system is expected to be used by both power plant operational staff and by regulatory agency personnel. Because of the significant cost impact from stack emission violations, your system must specifically be designed to measure both current and proposed levels of these gases, and to be acceptable to all stakeholders involved with coal-fired power plants.

YOUR DELIVERABLE

Your task is to write an internal proposal for your corporate officers describing your approach to this problem. Be sure you address all of the following:

Current State-of-the-Art - What is already being done in this area by other researchers, companies and governmental institutions? The current state-of-the-art for both the science and the implementation should be described, making use of diverse resources such as science literature, journals, conference proceedings, the internet, patents or other sources of existing public knowledge. ***Be sure to cite all references that you use and to quote any word-for-word transfer to your report.***

Your Proposed Solution - Describe in detail your solution to this problem, including both the scientific/engineering basis and method of applying this to a workable solution. You must provide specifications and preliminary designs for both the transmitting and receiving units. Estimate the performance expected over all expected field usage conditions, along with a list of potential benefits and problems. System parameters that should be examined and described include portability tradeoffs, detection stability versus sensitivity, cost/benefit analyses of additional detection capability, and any other items that would give your system a competitive advantage in this technology and market space.

Testing and Qualification - Describe a set of tests and demonstrations that you will use to show the effectiveness of your approach. These should include tests that demonstrate that the systems can work as intended in the operational conditions to which they will be subjected.

Cost Analysis - At least in qualitative terms, describe the factors that will enter into the cost analysis for developing your sensor and instrumentation unit. You should plan first on manufacturing enough units for testing and qualification by the appropriate regulatory agencies, and then extrapolate those costs to production of 500 – 1000 units per year. Be reasonable, and clearly justify the major performance/cost tradeoffs you choose and then use this as an

introduction to then discuss your expectations of the competitiveness of your product and what would be the expected return on investment, fully explaining your assumptions.

Intellectual Property - List in rank order of importance all commercial, academic, and governmental IP sources that were consulted while formulating the answer, including key important reference data, as an appendix to this exam. For instance, if the IP source is a patent, include the patent number; title; inventor name; and assignee name. (The full list will not be counted as part of the 15-page limit.) The three that are the most significant threats to your solution should be discussed within the 15-page document, making comparisons of strengths and weaknesses of these approaches relative to your own.

Most importantly - this is just a minimum list of issues you might consider. There may be many more. The point is that your report *should contain the evidence* needed to make an effective and compelling case to your CEO in order to insure that she makes the right decision.

Hint - Your report should read like a story – one logical step followed by another. This will help you stay focused! Re-read along the way to be sure that you have one logical step followed by another.