

The Furnace

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Type: Open-ended Problem
Student Time: Three Weeks
Location: Lab/Home

Summary

The project is to solve a problem that involves trade-off decisions on multiple parameters. The problem of concern is the electromagnetic interference generated by an advanced design furnace system. Although the furnace was designed with environmental considerations in mind, customer complaints have indicated that the furnace produces electromagnetic interference, which may be seen as a form of pollution. The student must consider the ethical, legal, and economic aspects of the design decision and propose a direction for management to take in resolving the customer complaints.

ABET Descriptors

Engr Sci Content: First Year Engineering
Type: Component
Elements: Synthesis, construction, test and evaluation
Features: Development of student creativity, use of open-ended problems, consideration of alternative solutions
Constraints: Economic factors
Effort: Team

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Your first job assignment is as a product engineering team member in a small company specializing in the manufacture of natural gas furnaces. Your company is very proud of their new design, a high efficiency natural gas furnace that utilizes a pulse burner. The pulse burner allows a chamber to fill with a gas/air mixture then ignites the mixture with electrical spark. The gasses in the chamber burn efficiently, then the chamber re-fills and the process repeats.

The new furnace design is slightly more expensive than the competitor's model, but the design has been well received by customers interested in a long-term cost saving. Several of the major customers have been developers of large-scale housing projects. The developers have been specializing in homes with "energy efficient" features.

The company has now delivered over one thousand units, and in general the new units have been well received by the homeowners. There have been some complaints from a few isolated customers. The pulse mechanism emits a low-level electromagnetic pulse which repeats at a period of about fifteen times per second. Owners of the unit that live in the city have few complaints, but owners in rural areas complain of difficulty in radio and television reception. Two city residents have received complaints from the local fire and police departments about interference with the two-way radio communication system in buildings adjacent to those containing the furnace.

You have received the following guidance:

Customer #1: Please come and remove this equipment from my home and replace it with something that works! My ham radio goes nuts whenever it turns on!

Customer #2: The police department has made me turn off the furnace - it interferes with their radio. Winter will be here in two weeks, what can I do?

Customer #3: I can not receive "As the Third Rock Rotates" on channel 3 whenever your darn fan turns on....Come fix it! Tomorrow Jessica is getting married and I have to find out what happens!

Your Boss: We don't have a problem. There are no regulations on EMI (Electromagnetic interference) applicable to furnaces.

His Boss: There are over 1,230 units out in the field. We make only \$500 on each unit we sell, and it will take a total redesign to fix this problem. We cannot redesign every unit in field just because three local yokels complain.

Her Boss: This is a real problem, make it go away, and soon! Give the job to design team #17, they're good at new problems....

Your friend,

Co-worker: Uh...I never thought of EM-whatever-it-is. Is that important?

Golf Partner: Didn't they have a problem like that at GM? Almost cost the entire company to get it solved. I'll bet this is the tip of the iceberg.

Bridge Partner: Do what Intel does: just fix the units that belong to customers with a complaint.

Neighbor: Don't sweat the small stuff. First of all, it probably is not a problem. If it is, it doesn't hurt anybody. They had the same discussion over carrying computers aboard airliners two years ago - there's nothing wrong with that!

Customer #3: Becomes frustrated and complains to the FCC about television interference from your product.

Your design team has been asked to consider this situation. First of all, is there a problem? We certainly have a situation! Consider the above situation/problem in light of economics, ethics, and legal issues.

Provide an engineering report that will discuss the situation, provide an analysis of the perceived problem, and provide a recommendation to management concerning what action (if any) would be best.

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Engineering Notes:

The three customer complaints could be the “tip of the iceberg”, indicating much trouble in the near future, or could be just isolated complaints. The furnace was not designed with EMI considerations in mind and will continue to cause interference until the situation is rectified.

Objectives/Comments:

Be prepared to discuss theory behind EMI, to guide the students toward literature concerning EMI, treatment of EMI, legal and ethical aspects of engineering, and engineering manufacturing economics.

Expected Outcomes:

It is not obvious how much work will be required to re-design or retrofit the furnace system. The student is expected to research the regulations concerning EMI generated by home appliances, note that equipment may be compliant but still generate problems, and be able to address the FCC inquiry with either a plan of action, or statement that the equipment will meet legal specifications (as applicable). The economic problem of customer satisfaction must be addressed, and the ethical-economic tradeoff between environmental concerns vs. a reasonable level of affordable EMI isolation must be decided.

Discussion/Follow Up:

Let the students critique each others recommendations.