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Oil, Gas & Energy Law Intelligence

Pipeline Engineers: Ethics, Responsibilities, and Competency by P. Hopkins

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PIPELINE ENGINEERS: ETHICS, RESPONSIBILITIES, AND COMPETENCY

Hopkins, P[1]

ABSTRACT

In recent years the pipeline business has been closely scrutinising pipeline 'integrity': we expect our pipelines to be safe, and consequently require them to have high levels of integrity.

'Integrity' has various definitions, ranging from 'moral soundness' to 'the state of being entire or complete'. The latter definition is appropriate to pipelines, but the former is appropriate to pipeline engineers. This leads to the question… how do we ensure that our engineer has high levels of integrity?

All professions have responsibilities, and the engineering profession is no different: it has responsibilities, and is bound by codes of ethics.

This paper discusses the ethics and moralities of the engineering profession. These are important issues to engineers; their work will take them to regions of the world where there is social injustice, the profits from the oil and gas may not find their way to the people, and where protecting peoples' cultures and their environment is the major consideration. Also, engineers will need to come to terms with the high profits made by the oil and gas businesses, and the fact that much of these profits come from the developing world, and an energy-type that is creating global warming.

The paper is intended as a simple ethical guide to all engineers working in the oil and gas business.

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1. INTRODUCTION

In recent years the pipeline business has been closely scrutinising pipeline 'integrity': we expect our pipelines to be safe, and consequently require them to have high levels of integrity. Some definitions of 'integrity' are: 'soundness'; 'the state of being unimpaired'; 'the quality or condition of being whole or undivided'; 'completeness'. These are all highly appropriate definitions of integrity for pipelines, and we ensure a pipeline has this integrity by using engineering codes of practice, and recognised procedures to both design and operate the pipeline.

Another definition of 'integrity' is more personal: 'steadfast adherence to a strict moral or ethical code'. This leads to the question… how do we ensure that our pipeline engineer has integrity?

This paper[2] addresses the ethics and responsibilities of an engineer that should ensure that he or she has the same high level of 'integrity' as a pipeline!

1.1 Work….

We all have to work for money. Some of us are lucky: we also do a job we enjoy. The luckiest people are those that both enjoy their jobs, and know their jobs contribute to social welfare.

The oil and gas business is a big, international business: Exxon Mobil, the world's largest publicly quoted oil and gas firm, made $US25billion profit in 2004. These earnings are approximately equal to the gross domestic product (GDP) of Luxembourg or Guatemala, and higher than the individual GDPs of Syria, Bulgaria and Kenya. In 2004, Shell recorded the biggest profits ever by a British company. The $US18billion earned in 2004 from oil and gas - $2million an hour – is equal to nearly 1% of Britain's GDP!

People working in this business may be exposed to ethical and professional situations where they have to make decisions, not based on the good of the company, but on their personal beliefs and social responsibilities.

This paper covers our responsibilities in engineering, and hopefully will show that money isn't everything, and an engineer cannot be bought!

We are going to talk about ethics, and this is highly relevant to pipeline engineers. For example, we may work for companies with interests in Nigeria, or, like the author of this paper, have worked on projects in Nigeria. Nigeria is an 'oil-rich' country but its people are very poor: its population of 130,000,000 have an average salary of $1/day. Its government is striving to eliminate corruption which affects the redistribution of the oil revenues of over $25 billion/year. Should we work for companies with interests in Nigeria?

A perspective on the problem was given by the Nigerian Finance Minister when she was interviewed on BBC Radio 4 on 14th January 2005. She said that if all the oil revenue was given to the people, they would only receive an extra $0.5/day.

This can be viewed in two ways:

- a $0.5/day increase in salary is negligible by world standards, and would not remove poverty from Nigeria;
- a $0.5/day increase in salary is a 50% increase for that person, and would significantly increase their quality of life.

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[2] This paper is the final paper in a series of four papers (see also References 1 to 3) that has addressed change and ethical issues in the pipeline business.

Is corruption the problem causing poverty in Nigeria? Is the oil business contributing to Nigeria's problems or alleviating them? Is the oil business, and the profits going to the government and the oil majors, the problem?

Also, we will be working in countries, or working on oil from countries, that may not be democratic, or may not have good human rights records. For example, the fifteen countries which have oil reserves in excess of 10 billion barrels are:

Country	**Oil Reserves (billions of barrels)**
USA	22
Mexico	12
Venezuela	78
Norway	10
Russia	60
Canada	180
Libya	30
Nigeria	24
Iraq	113
Iran	89
Kuwait	97
UAE	98
Saudi Arabia	261
China	18
Qatar	15

Engineers faced with projects in such countries need to carefully consider all morality, safety and environmental aspects before agreeing to participate.

1.2 What is 'Engineering'?

There is little point in talking about ethics in engineering without first understanding what 'engineering' is!

Engineering means 'skilled' or 'creative'. Engineers have to research, design, build and operate machines, structures, etc., that will function safely and efficiently. Engineering is a powerful and prestigious profession. Engineers can save companies millions of pounds in the developed world by clever designs, and can save thousands of lives in the developing world by working on energy projects to provide power to their industries, or working on infrastructure projects such as water pipelines to give people clean water. Engineers can make a big 'difference' in the world.

An engineer will use scientific laws to solve practical problems. It is difficult to differentiate between scientists and engineers, but one way is to view a scientist as asking *"why?"* and then he/she researches the answer to the question. By contrast, engineers want to know "*how*" to solve a problem, and how to implement that solution.

'You see things and you say "Why?" But I dream things that never were; and I say "Why not?" George Bernard Shaw*.*

1.3 Legal Duties

We all must obey national and international laws. Engineers will be faced with many laws (for example, contract law), and hence we need to consider our legal duties.

This paper is not an in-depth analysis of our legal duties – these will vary from country to country. However, we will cover certain legal responsibilities: this is important as engineers can be held responsible for their actions and face penalties. Remember… we live in a very litigious society; be aware of all your duties and responsibilities, and always put safety first.

1.4 Responsibilities

"Responsibility: A detachable burden easily shifted to the shoulders of God, Fate, Fortune, Luck or one's neighbour. In the days of astrology it was customary to unload it upon a star." Ambrose Bierce, The Devil's Dictionary, 1911.

We have many responsibilities in our lives. They can be family (e.g. care for your children), social (e.g. care for your neighbour), professional (e.g. care for your clients), spiritual (e.g. satisfying our conscience) and political (e.g. care for developing countries).

First of all… what is 'responsibility'? Responsibility usually means we are expected to achieve or maintain a result, as we have the required knowledge. It does not require 'perfection', because we may not always achieve the result:

- a responsible physician may see a patient die;
- a responsible engineer may witness his design failing in an unforeseen accident.

Engineers have many responsibilities. We always think of three of the more obvious:

- professional – the responsibility that arises from a special knowledge;
- company– these are our 'official' or specified duties in our job;
- legal – those required by society.

We would expect to behave in a professional manner at all times, as we are called professional engineers. Also, we would always expect to behave in a right and proper manner to our company, within the law of the land, to satisfy both our own morals, and the employment contract.

Therefore, we are familiar with our professional and work obligations, but engineers now have many responsibilities beyond these simplistic professional ones. When we design a component, conduct a calculation, give a view, etc., we are making a decision, and hence we have responsibilities to all 'stakeholders' in those decisions. These stakeholders include the engineer and others; for example:

- the company we work for;
- the client we are making the decision for;
- any person or environment that may be affected by this decision.

We can illustrate this by considering designing a hotel elevator: the stakeholders are our client who ordered the elevator, the owner of the hotel, and all persons who travel in the elevator. Consequently, we are answerable to many stakeholders and liable for our decisions, and our 'professionalism' goes beyond ourselves and our company.

Additionally, we are now in a 'global' economy, and engineers will increasingly be asked to work on projects in countries that have poor human rights, or poor environmental records. This means we may be faced with questions of morality and conscience. Again, an engineer must now consider these aspects in his or her work.

All the above can be grouped into three areas:

- loyalty: to your profession and company;
- ethics: in dealing with matters of conscience and morality;
- duty of care: to all stakeholders in your decision-making.

Obviously, these areas are linked together, but to give this paper some structure we will start by talking about ‘loyalty’ and ‘ethics’, then move on to ‘duty of care’.

2. LOYALTY [1,2,3]

2.1 What is 'Loyalty'?

You can find various dictionary definitions of loyalty. Here is one:

'Loyalty - friendship or duty towards something or somebody'.

Loyalty is a confusing concept. We can see people being 'loyal' to family members, even a football team, but to a company? To a profession? To a customer?

A good example of loyalty is a pet. Dogs and cats can fetch a stick, or purr on your knee, and only require a meal per day in return. A dog is fanatically loyal: a dog will exhibit lifelong loyalty to everything, ranging from you, to an old slipper.

Even if you do not feed a dog, it will remain by your side. A cat is different: his or her loyalty is merely a business deal: feed me, and you have my loyalty and affections, stop feeding me, and I'm gone.

Also, a dog's loyalty is unquestionable: shout 'sit' into a room full of cats and dogs, and all the dogs will sit, but the cats will look long and hard at you, and think – *"are you winding me up?"*. A cat can show real and ferocious loyalty: try and steal a kitten from its mother; but it cannot understand why dogs loyalty can extend to giving up their lives in the protection of a deflated football.

We will now look at loyalty issues that an engineer will face in his or her profession.

2.2 Loyalty to a Company – an Older View

Our forefathers viewed loyalty to a company as a mark of distinction. Loyalty was usually identified by long service. Today, this can be the 'kiss of death' to your career. Prospective employers may be suspicious of an applicant who has been with one company for a long time. Where is the ambition? Where is the varied experience? Where are the new skills?

Obviously, any new employer will be suspicious of an applicant who changes their job every six months, so there is a balance needed when considering how long to stay with a company in terms of your career prospects.

2.3 Loyalty – the Modern View

Loyalty is a quality that is becoming increasingly difficult to find, whether it is employee loyalty to a company, or consumer loyalty to a product.

In the past, employees believed when they were hired by a company, it would last until they retired. Starting in the 1980s, as companies sought to increase profits, workers' perceptions of lifetime employment were shattered by corporate downsizing, company relocations to other states or countries, and static wages.

This is why older workers are more likely to express corporate loyalty, but they are also more likely to feel betrayed by corporate actions.

A report on corporate hiring priorities gives us an insight into how the 'new' world views loyalty: the survey was conducted by Vault Reports, a New York City-based employment research firm. Vault Reports asked college career-centre professionals what they thought employers are looking for in new hires. The top items were phrases such as "team player," "intelligence" and "professional demeanour." Finishing next to last, No. 10 on a list of 11 items, was "loyalty.

The above shows us that there is a modern (lower importance) view of loyalty. However, in this section we are looking more at loyalty to a company in terms of decisions made ‘on the job’ rather than to further your career.

2.4 Corporate Loyalty

Most professional engineers are employed by an organisation. An engineer will have an employment contract and ‘Terms and Conditions’ will require some ‘loyalty’, e.g. a long notice period, and a company’s rewards package (e.g. large pension) may be seen as warranting some loyalty in return. Ensuring loyalty by good pensions, company cars, etc., is a simple buying method.

Beware of companies and managers who use words such as *‘pride, commitment, teamwork’* as a reason to work harder or longer: these are words that managers use to get staff to work for free. Instead, companies need to offer tangible benefits as incentives for loyal staff. Hence, policies and procedures must be in place that give staff confidence that any loyalty they show will be rewarded. For example, longer notice periods, company equity schemes, and other rewards for competence and commitment.

This is similar to supermarkets’ ‘loyalty’ cards - because they pay you back (1% refund of everything you spend) for your custom. Again, a simple financial deal.

2.5 Loyalty: A Legal Definition

‘Loyalty’ is a very abstract word, but a definition [4] from a court in Maryland, USA gives some important guidance:

‘… an implied duty that an employee is to act solely for the benefit of his or her employers in all matters within the scope of employment.’

2.6 Loyalty and the Engineer

An engineer must make his or her own decisions on loyalty to a company in terms of his or her career progression; however, in our professional work, we do not owe unqualified loyalty to a company, as this would be a sacrifice of an employee’s autonomy. For example, a maintenance manager who tells a maintenance engineer to ‘watch costs’, is behaving in a reasonable, legitimate manner, but if this manager asks the engineer to cut costs by neglecting certain agreed procedures, then the engineer is placed in a difficult position.

The above legal definition of loyalty helps an engineer in these circumstances; if an illegal or dangerous act is being proposed, it is not to the benefit of the company.

And remember, in certain circumstances, a professional code of ethics may contain an expression of public policy, and a professional may be expected to abide by this professional code as well as federal and state laws. That duty may oblige them to decline certain acts requested by an employer. Note that almost all the engineering codes of ethics in the USA. include as a provision, *"Engineers shall act in professional matters for each employer or client as faithful agents."*

We will discuss this further under ‘ethics’, as we must never let our company or personal loyalties break ethical barriers. The major point for an engineer to remember is that their main loyalty and responsibility is to the general public, whom they serve. And this leads to a simple priority for any engineer: safety!

3. ENGINEERS' ETHICS

'What is moral is what you feel good after, and what is immoral is what you feel bad after'. Ernest Hemingway.

Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Additionally, engineers must perform under a standard of professional behaviour that requires adherence to the highest principles of ethical conduct.

"Ethics" has at least three meanings in English: it can be [5]:

1. a synonym for ordinary morality, - "Morality", refers to *those standards of conduct everyone (every rational person at his rational best) wants every other to follow even if everyone else's following them would mean having to follow them too*. Morality (in this sense) is the same for everyone, engineers included.
2. the name for a field of philosophy, or
3. the name for a set of special (morally permissible) standards (for example, engineering ethics, see Section 3.2.1)).

This section considers ethics and engineering, but other aspects of life cut across engineering. For example, the British Government recently (December 2001) was faced with an ethical problem when asked to grant an export licence. Tanzania, one of the world's poorest countries (half the population do not have access to clean water, over half live below the poverty line, with a per capita income of $250 a year) and in the top 10 list of most corrupt countries in the world, placed a $40million order with a British Company for a military air traffic control system. International 'arms' dealing has been recognised as corrupt for decades. The order, if accepted, protected 250 engineering jobs in the UK. How should the government react, and how can the 250 engineers ethically justify producing the equipment?

3.1 Moral Standards

In 'Prospects for International Standards' by Vivian Weil she reflects on common moral standards; we refer to them as our 'common morality'. Her colleague, Michael Davis has usefully characterized our common morality**:** *"Don't kill," "Don't deceive,"* and *"Don't cheat"* are among the standards of our common morality.

Our common morality, provides a fundamental framework of standards to appeal to in reasoning about cases. We have an additional framework: the codes of ethics promoted by the professions through their professional associations. These ethical standards are special sets of standards adopted by occupational groups and binding upon the members of the group, because they are members of the group.

3.2 Professional Standards/Ethics[3]

Using the above description of common morality, allows professional standards to be defined as those *"morally permissible standards of conduct each member of some particular occupational group wants every other member of the group to follow, even if everyone else's following them would mean having to follow them too."*

A profession's ethical standards must be compatible with our common morality, but they go beyond: they interpret our common morality for the specific details of work of a particular

[3] 'Ethics' is the conventional term in the USA for 'professional standards'.

occupational group. As stated above, almost all the engineering codes of ethics in the U.S. include as a provision*, "Engineers shall act in professional matters for each employer or client as faithful agents."* Avoiding injury to the employer or client is a requirement for engineers, specific to their conditions of practice.

3.2.1 Engineers' Responsibilities and Ethics

The American Society of Mechanical Engineers (ASME) considers that engineers should uphold and advance the integrity, honour, and dignity of the engineering profession by:

- Using their knowledge and skill for the enhancement of human welfare;
- Being honest and impartial, and serving with fidelity the public, their employers and clients;
- Striving to increase the competence and prestige of the engineering profession.

These fundamental responsibilities lead onto a set of fundamental rules ('canons'):

1. Engineers shall hold paramount the safety, health and welfare of the public...
2. Engineers shall perform services only in areas of their competence.
3. Engineers shall continue their professional development throughout their careers and… provide opportunities for the… development of those engineers under their supervision.
4. Engineers shall act in professional matters for each employer or client… and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall associate only with reputable persons or organisations.
7. Engineers shall issue public statements only in an objective and truthful manner.
8. Engineers shall consider environmental impact in… their professional duties.

Other professional engineering organisations have similar rules; for example, the Engineering Council in the UK under its 'Roles and Responsibilities of Chartered Engineers' [6] states that an engineer has *'…a responsibility to society with regard to safety, to their legal and contractual obligations, and for the ethical and environmental impact of their work'*.

3.2.2 'Canon 1'

Professional codes, then, reflect our common morality and the circumstances of practice in a particular society. Circumstances change and codes undergo revision, as professional societies respond to pressures from outside and from within the world of practice. Currently, professional engineering societies in the USA are beginning to respond to widespread concern about the environment. Some engineering societies have considered whether existing codes already encompass protection of the environment, by way of Canon 1 (see Section 3.2.1): *"Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties."* Two societies have added provisions regarding the environment to their codes.

Around 1970, all the major professions came under closer scrutiny than before, and they had to respond to demands for accountability to the public. Canon 1 of the engineers' codes serves as a touchstone for engineers and engineering students who are trying to resolve problems. It does not imply specific solutions, but it reminds engineers of their weightiest obligation as professionals.

Ethical codes, like technical codes, respond to problems that engineers commonly encounter. At each stage in their development, codes represent the consensus of a particular community of engineering professionals, and they, in turn, help to define a community of engineering professionals. Both ethical and technical standards are part of, and expressions of, the expertise of engineers.

3.2.3 Do we have to take note of Engineering Institution's Ethics Policies?

If we are a member of an engineering institution that has an ethics policy, society will expect us to adhere to it.

Many engineers are not members of engineering societies: membership, and obeying their rules, are not legal requirements. Do societies ethics codes, etc., apply to these engineers? An engineer's obligations do not rest on an 'oath' or membership of a society; however, if you call yourself an 'engineer' or have an 'engineer' job title, society (and the law) will expect you to behave as a responsible engineer.

The law would consider engineering societies rules, and if they are rational, they will expect any engineer to follow them. You may not be a member of ASME, etc., but a lawyer and the general public may consider you have a 'contract implied by law' with this type of society.

3.2.4 Engineering Standards and Codes[4]

Safety is a leading ethical concern in engineering: this concern underlies technical standards and becomes explicit in codes of ethics. Engineering knowledge and guidance is translated into codes and standards that are used by industries, but all codes and standards leave scope for individual judgment, and this is where ethical codes help engineers.

Standards give engineers guidance and advice in a straightforward manner; however, the process by which codes shape practice is not straightforward. As a British scholar recently said, *"Why should the use of standards be more straightforward than their development?"* .

Engineering societies voluntarily produce not only standards but also documented discussions and accounts of debates that occur in the process of deliberating about standards. These are published in their journals, websites, etc..

3.2.5 Linking Engineering Standards and Laws

It is not usually legally mandatory to conform to engineering standards, but following them satisfies legal safety regulations, which are mandatory.

The failure to meet appropriate engineering standards, even when there is no violation of government regulations, can leave a company vulnerable in a product liability lawsuit. There is, then, in the face of legal standards, a basis for continuing to emphasize good engineering standards, ethical as well as technical, and to advance those standards by incorporating new knowledge.

3.3 Don't Forget Training!

'There is nothing training cannot do. Nothing is above its reach. It can turn bad morals to good; it can destroy bad principles and recreate good ones; it can lift men to angelship'. Mark Twain.

All engineers are required to continue their professional development (See Section 3.2.1). We must keep up to date, and be aware of new technologies and methods. If we do not – we are failing in our duties.

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[4] What is the difference between a 'code' and a 'standard'? ASME considers a *'standard'* as … 'a set of technical definitions and guidelines - "how to" instructions for designers and manufacturers. Standards, which can run from a few paragraphs to hundreds of pages, are written by experts'. Standards are considered voluntary because they serve as guidelines, not having the force of law.
A '*code'* is… 'a standard that has been adopted by one or more governmental bodies and has the force of law, or when it has been incorporated into a business contract'.

In some countries it is a legal requirement to have a formal training programme for pipeline engineers. For example, in the USA, the Federal Register Part 49 CFR 192.763 (pipeline integrity management in high consequence areas) requires:

‘An operator’s integrity management program must provide that each supervisor… has appropriate training or experience in the area for which the person is responsible [and] must provide criteria for the qualification of persons who review or analyze results from integrity assessments and evaluations….’

We will mention training again in Section 5.4.2.

4. THE ENGINEER AND CLIMATE CHANGE [7,8,9]

We cannot talk about the ethics of engineers in the oil and gas business without talking about its impact on the environment.

Oil and gas brings many benefits to society, and is an essential part of modernday living: we cannot survive without it. In recent years, many scientists have highlighted the impact on our environment of burning fossil fuels: this impact can be highly damaging, particularly on our climate, and have long term consequences to our planet.

Over the last two decades, scientists have observed a slight increase in temperature on the surface of the earth[5]. Some attribute this to an increased concentration of 'greenhouse gases' in the atmosphere. The most important greenhouse gases are: carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride.

The main greenhouse gas of concern to policy makers is carbon dioxide. It traps some of the radiation that would otherwise be lost to space, and causes the Earth's atmosphere to be warmer than it would otherwise be.

We all contribute to greenhouse gases in the atmosphere: driving a car, using electricity obtained from fossil fuels, etc. Similarly, when farmers in Brazil, or the United States or China, clear or burn forests to create new farm or grazing lands, emissions are also increased. That explains why actions by man are central to the climate change debate.

4.1 Is Climate Change Really a Problem [10]?

Thousands of climate scientists, ecologists, technologists and economists from round the world formed an Inter-governmental Panel on Climate Change in 1988, under the auspices of the United Nations. The panel's pioneering assessments amount to a scientific consensus on climate change, its likely impacts, and what we can do about it. Its early reports persuaded governments of the seriousness of the problem and informed the negotiations of the Kyoto Protocol (see next section).

One of the central conclusions of the panel's work to date is that, whatever we do now, significant climate change is now unavoidable. It will take decades to bring emissions of greenhouse gases under sufficient control that the concentrations of the gases in the air stop rising.

The International Energy Authority's (IEA) World Energy Outlook 2002 stated that global energy-related emissions of carbon dioxide are projected to increase by 1.8% per year from 2000 to 2030, reaching 38 billion tonnes in 2030. This is 16 billion tonnes, or 70% more than today (2002). Two-thirds of the increase will come in developing countries. China alone will contribute a quarter of the increase in carbon dioxide emissions, or 3.6 billion tonnes, bringing its total emissions to 6.7 billion tonnes per year in 2030. Even then, however, Chinese emissions remain well below those of the United States.

4.2 Kyoto Protocol

In 1979, the first United Nations' World Climate Conference explored how climate change might affect human activities, and issued a declaration calling on the world's governments *"to*

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[5] CO_2 levels have risen from an average of 280 ppm (parts per million) over the last millennium to a current level of 370 ppm and continue to rise by 1.5 ppm per annum. Indeed, levels are at their highest for 400,000 years. Most scientists believe that human activity is causing that increase. Concurrently, an average global temperature rise of 0.6°C has been observed since 1860 [11].

foresee and prevent potential man-made changes in climate that might be adverse to the well-being of humanity". The United Nations subsequently helped to develop the 'Kyoto Protocol': this protocol requires participating nations - almost all from the developed world - to reduce their greenhouse gas emissions to five percent below 1990 levels during the five years from 2008 to 2012.

4.3 Climate Change and the Pipeline Engineer

Pipeline engineers work in a business that is known to create global warming; consequently, they need to be confident that their profession and companies understand this impact and are contributing to its mitigation. For example, many oil and gas majors are working on 'greener' fuels, but this is a slow process: a review by the UK's Royal Academy of Engineering of the cost of generating electricity in the UK from different energy sources concluded that natural gas was the best option, and renewable energy sources were more expensive [12], Table 1.

An engineer has to accept the damaging aspects of burning fossil fuels, and be convinced that – on balance – it contributes to the welfare of the people it serves, and that also his/her company is aware of their duties in reducing these damaging aspects.

Method of Generating Electricity	**Cost[6] (pence[7]/kWhour)**
Gas-fired combined cycle gas turbine (CCGT)	2.2
Nuclear fission plant	2.3
Coal[8]-fired pulverised-fuel (PF) steam plant	2.5
Coal-fired circulating fluidized bed (CFB) steam plant	2.6
Coal-fired integrated gasification combined cycle (IGCC)	3.2
Onshore wind farm	3.7-5.4*
Offshore wind farm	5.5-7.2*
Wave and marine technologies	6.6

* Cost increases if back-up power generation is needed. The costs ignore environment impact.

Table 1. Alternative Energy for Electricity Generation

[6] These costs assume no penalty is being paid by the fossil fuels for creating CO_2. If taxes/penalties are levied, then nuclear and the renewable sources become more competitive.
[7] 1 pence = £0.01.
[8] Coal is one of the 'dirtiest' fuels and produces the most CO_2; hence, it is causing most damage in terms of global warming.

5. STANDARD (DUTY) OF CARE

Before we start this section, we need to note the single word that sums up an engineer's responsibilities, ethics, standard of care, etc.: **SAFETY!**

Engineers have always been responsible for their work, and their failures; for example, 3000 years ago, Hammurabi the greatest ruler (1795bc-1750bc) of Babylon[9], produced a remarkable list of codes and laws for his people. It is the earliest complete legal code known. They were engraved in 2.4m high blocks of granite.

One of these laws was… *'If a builder builds a house for some one, and does not construct it properly, and the house which he built falls in and kills its owner, then that builder shall be put to death'.*

5.1 Engineer's Duty

Engineers have a duty to provide their services in a manner consistent with the "standard of care" of their professions. Two good working definition of the standard of care (both taken from the USA legal system) of a professional are:

- *that level or quality of service ordinarily provided by other normally competent practitioners of good standing in that field, contemporaneously providing similar services in the same locality and under the same circumstances'; or*
- *that which is commonly possessed by members of that profession or trade on good standing. It is not that of the most highly skilled, nor is it that of the average member of the profession or trade, since those who have less than median or average skill may still be competent and qualified'* [13].

An engineer's service need not be perfect: since the engineer, when providing professional services, is using judgment gained from experience and learning, and is usually providing those services in situations where a certain amount of unknown or uncontrollable factors are common, some level of error in those services is allowed.

When you hire an engineer you *"purchase service, not insurance,"* so you are not justified in expecting perfection or infallibility, only "reasonable care and competence". The fact that an engineer makes a mistake that causes injury or damage, is not sufficient to lead to professional liability on the part of the engineer. In order for there to be professional liability, it must be proven the services were professionally negligent, that is, they fell beneath the standard of care of the profession. When one hires an engineer, one accepts the risk, and the liability, of that professional making a mistake similar to mistakes other normally competent engineers make, using reasonable diligence and their best judgment.

The standard of care is not what an engineer should have done in a particular instance, it is not what others say an engineer would do, or what others say they themselves would have done, it is just what competent engineers actually did in similar circumstances.

5.2 'Error'

Error is fact of life: *"To err is human."*

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[9] Babylon is Iraq and the northern parts of Syria.

Some error comes from variability and uncertainty in what the engineer is dealing with: real materials, natural and man-made loads, and humans and their organizations. Error can lead to failure, which can cause injury, and result in damages.

An engineer is not liable, or responsible, for damages from every error. Society has decided, through case law, that when you hire an engineer, you buy the engineer's normal errors. However, if the error is shown to have been worse than a certain level of error, the engineer is liable. That level, the line between non-negligent and negligent error, is the "standard of care." We will now deal with both negligence and standard of care.

5.3 Determining 'Standard of Care'

5.3.1 General

A trier of fact (a judge or jury), has to determine what the 'standard of care' is and whether an engineer has failed to achieve that level of performance. They do so by hearing expert testimony. People who are qualified as experts express opinions as to the standard of care and as to the defendant engineer's performance relative to that standard. The trier of fact weighs the testimony from all sides and decides in each case what the standard of care was and whether the defendant met it.

Jury instructions have been standardised. A Bench Approved Jury Instruction in the USA reads:

> *"In performing professional services for a client, a (structural engineer) has the duty to have that degree of learning and skill ordinarily possessed by reputable (structural engineers), practicing in the same or similar locality and under similar circumstances.*
>
> *"It is (the structural engineer's) further duty to use the care and skill ordinarily used in like cases by reputable members of the (structural engineering) profession practicing in the same or similar locality under similar circumstances, and to use reasonable diligence and (the structural engineer's) best judgment in the exercise of professional skill and in the application of learning, in an effort to accomplish the purpose for which (the structural engineer) was employed.*
>
> *"A failure to fulfil any such duty is negligence".*

Four key items in this instruction are worth repeating:

- ...have learning and skill ordinarily possessed by reputable engineers practicing in the same or similar locality and under similar circumstances.
- ...use care and skill ordinarily possessed by reputable engineers practicing in the same or similar locality and under similar circumstances.
- ...use reasonable diligence and best judgment.
- ...to accomplish the purpose for which the engineer was employed.

If any one of these conditions is not met, the engineer has failed to meet the standard of care, and is professionally negligent. Finally, it is worth repeating that the standard of care varies with time, locale and circumstances.

5.4. ‘Negligence’ and ‘Competence’

5.4.1 ‘Negligence’

You may be accused of ‘negligence’ in any profession. Section 5.2 noted that the line between a non-negligent and negligent error, is the "standard of care”, and negligence is a failure in your standard of care. Obviously, you will not face litigation solely for not meeting this standard of care; in law, you can be called ‘negligent’ if [14]:

- a duty of care existed between parties;
- the defendant breached the duty;
- as a result of that breach the claimant sustained damage.

To avoid being negligent an engineer must show that he/she has made all the ‘preparations’ that a reasonable man/woman (see next section) in this position would recognise to prevent unreasonable risk. In all civil cases the claimant is required to prove his or her case on the 'balance of probabilities'. This simply means a Judge has to be persuaded that the claimant’s version of events is more likely to be true than the defendants.

5.4.2 ‘Competence’

We often hear that an engineer needs to be ‘competent’. A definition from a pipeline organisation [15] is:

‘A Competent Person should have practical and theoretical knowledge as well as sufficient experience of the particular machinery, plant or procedure involved to enable them to identify defects or weaknesses, and to assess their importance in relation to strengths and functions of the machinery’.

All engineers need to have the required basic qualifications, then ensure they are up-to-date with both ‘practical and theoretical’ knowledge. This means continual professional development; for example, the Institution of Mechanical Engineers in the UK requires its Chartered Engineers to be *‘… competent throughout their working life, by virtue of their education, training and experience…’*.

How does this relate to a pipeline engineer? Until recently, there have been no academic engineering courses specially for pipeline engineers. This is now changing: there is a dedicated pipeline engineering masters program at University of Newcastle, UK, and the Catholic University in Rio, and University of Calgary, are offering, or will offer, extensive pipeline engineering education at both under-graduate and post-graduate levels. Additionally, the American Society of Engineers now has a division devoted to pipeline systems.

A basic education needs to be followed by both experience and continuous training;. Note that training alone is not sufficient: *‘Just because you’re trained for something, doesn't mean you’re prepared for it’. Anonymous.*

It is of interest to list the modules on the University of Newcastle’s masters program in pipeline engineering, to show how wide a pipeline engineer’s knowledge needs to be. The modules are:

- Fundamentals of Pipeline Engineering;
- Design and Construction;
- Asset Management;
- Economics for Pipeline Engineers;
- Hydrocarbon Processing and Production;
- Corrosion and Corrosion Control;
- Materials and Fabrication
- Dynamics of Offshore Installations;

- Pipeline Structural Integrity;
- Civil and Geo-technical Engineering;
- Safety and Environmental Engineering.

Obviously, it is a pipeline engineer's responsibility to ensure that any design or integrity assessment is correct. He/she should use the best possible practices available, check calculations, inputs and assumptions, and use all available data. These will include historical, current and circumstantial data (inspection data, operations records, maps, etc.).

An appreciation of the wider practical issues, and an understanding of all engineering aspects of the problem are required. This will require excellent data management support and internal communications.

5.5 'Reasonable Person' and 'Reasonable Care'

Section 5.3 discussed 'standard of care'. The legal profession also uses the phrases: 'reasonable care' and 'reasonable person'.

5.5.1 'Reasonable Care' and 'Accidents'

Accidents happen… but many 'accidents' should not be described as 'accidents'. If an 'accident' has preventable causes, it may become a criminal case!

And the fact that the engineers involved in the 'accident' did not intend an accident to occur, is not a defence. Was it an '*accident waiting to happen'*? It is a question of 'reasonable care': did the engineer(s) exercise 'reasonable care'?

In the USA 'reasonable care' [16] is… *'the amount of care that a reasonably prudent person would use in similar circumstances'* and we can easily relate this requirement back to our standard of care. If an engineer does not exercise this 'reasonable care' he/she may face prosecution.

5.5.2 The 'Reasonable' Person

The standard of conduct that the law imposes can perhaps best be understood in terms of the hypothetical "reasonable person" [14]. The law presumes that there is a standard of behaviour that a person of *'ordinary prudence, skill and care'* would follow in all situations, so as to avoid creating unreasonable risks of harm to others.

When dealing with professionals, or persons of superior learning or skill (such as engineers), the law imposes an even higher standard of care and diligence. In effect, it hypothesises a "reasonable engineer," whose conduct is guided by his or her special knowledge and expertise. In all instances, however, it is a jury of lay people who must decide whether challenged behaviour was, or was not, reasonable.

5.6 The Engineer and the Law

The previous sections have covered both 'standard of care' and 'reasonable person'. These are society's expectations and requirements for engineers, and these are the legal tests.

5.6.1 The Guilty Verdict…

Legal systems, laws and responsibilities vary around the world, but Section 5.4.1 summarised how an engineer may face litigation if he/she has been negligent.

Senior staff or directors of engineering companies may be liable to prosecution if they can be shown to have committed an offence:

- with their consent or connivance; or
- it was attributable to any neglect on the part of the officer/manager.

The test will be subjective: has the officer/manager deliberately turned a blind eye to something, or deliberately ran a safety risk? To prove guilt, the defendant must be proven:

- personally guilty of the offence; and
- be identified as the company's directing mind and will, on the subject: this 'identification principle' is the problem area.

5.6.2 Pipelines in the USA

Any major incident involving critical private infrastructure will be the subject of close law enforcement scrutiny. In the USA, for pipelines, these law enforcement agencies are: FBI, US Environmental Protection Agency, Department of Transportation, US Coast Guard.

These agencies will consider any incident causing environmental damage or injuries as criminal cases. An incident would be considered a crime if this 'harm' was linked to 'culpable conduct' [16]. The following evidence would show 'culpable conduct':

- history of repeat violations;
- deliberate behaviour;
- efforts to conceal;
- tampering with monitoring devices;
- activities such as false statements, obstruction, etc.

Companies[10] would face charges after the prosecutors have considered:

- was the offence serious (e.g. great harm)?
- were wrong-doings common in the company and corporate?
- was management aware of this?
- is there is a history of offences?
- did the company quickly identify and report the incident and respond to it effectively?
- has the company a 'compliance program' in place, and is it being applied diligently (e.g. were wrong-doers quickly disciplined)?
- would innocent shareholders or employees suffer disproportionately?

5.6.3 This is a Real Issue!

Pipeline engineers need to be very careful [17]… in 2003, a new level of personal liability was reached in the USA when a federal judge sentenced two pipeline engineers to jail time, following an explosion of a gasoline pipeline in Bellingham, Washington in 1999. It was the first time ever that pipeline employees had received jail time in connection with a pipeline accident.

A former company official was sentenced to six months in jail, while a control room manager received 30 days in prison and 30 days of home detention. A third employee, whose job involved monitoring the section of pipeline that ruptured, received a one-year probation and 150 hours of community service. It was alleged that the accident resulted from inadequate pipeline inspections following excavation work done five years earlier.

[10] In the USA a corporation can be charged with wrong doings – and the executives can be liable. This is because corporations act through the actions of individuals. Therefore, individuals can be liable to prosecution.

6. DISCUSSION

6.1 Globalisation

We are currently experiencing 'globalisation' that allows the economic integration of all world trading regions [3], and the oil and gas business, and the multi-nationals, are a key part of this change.

This means that the pipeline business and pipeline engineers have to adapt to this change and come to terms with the ethical issues it raises. This is particularly true when oil and gas is, and will be, extracted from poor and sometimes corrupt countries, and where oil and gas majors will continue to make record profits.

Engineers have to take a balanced view of their business and their own values (see Section 6.3), but certainly engineers should not be against multi-national companies making a profit, the expansion of their business, or to globalisation: as Kofi Annan, the UN secretary-general said, '*The poor are not poor because of too much globalisation, but because of too little.'*.

Kofi Annan speaks with authority, but we must be careful with our globalisation: the new wealth it can create can have both immediate and long term negative effects; for example, if we create highly paid jobs in the oil and gas business in a developing country we may reduce the attractiveness of becoming doctors or teachers in that country. Similarly, a short term focus on oil and gas riches may lead to long term harm in other industries.

6.2 Growth in the Developing World

Pipelines will be a key growth area as we expand our energy infrastructures around the world; consequently, pipeline engineers have key roles in our energy future.

The world already consumes over 28,000,000,000 barrels (1 barrel = 159 litres) of oil per year. A barrel of oil is currently (2005) about $US50: so, the oil business is worth $1.4 x 10^{11} per year! And we are expanding the oil and gas business: we are planning pipelines in new regions, and pipelines will be needed in many countries in the future, as these countries either have unused energy reserves, or energy needs. These are the regions pipeline engineering companies and engineers will be working in the future.

Surprisingly, it is the developing world that is going to account for the growth in energy demand. Consider the huge increase in the price of a barrel of oil in 2004: this major increase was not due to demand in the developed world: it was due to demand in the developing world [18]:

Region	**Increase in demand for oil, 1973 – 2003**
USA	+16%
European Union (EU)	-6%
Developing Countries	+203%

The developing countries are now (2003) consuming over 25 million barrels of oil per day, compared to about 20 million barrels per day in the USA, and about 14 million barrels in the EU.

This increase will continue; for example, Afghanistan is a very poor country, but it has 120 billion cubic metres of gas reserves, and 125 million tons of coal reserves. However, currently, 85% of the energy needs of Afghanistan are met by 'biomass[11]' energy, i.e. fuel

[11] 'Biomass' is organic material which has stored sunlight in the form of chemical energy. Biomass fuels include wood, wood waste, straw, manure, sugar cane, and many other by-products from a variety of agricultural processes.

wood, animal dung and agriculture waste. Fuel wood accounts for about 75% of the energy needs (cooking and heating) in rural areas, where most of the Afghanistan population lives. Soon, pipeline engineers will be working in Afghanistan, developing these reserves, but will the Afghan people benefit, or the oil and gas majors? Do the Afghan people have a say in these developments? Will protection of historical cultures, safety, and the environment, be the prime development considerations?

We need to show corporate responsibility in these developing countries. Indeed our oil and gas majors are now addressing such issues; for example:

- BP has agreed with the government of Azerbaijan that both sides will ensure greater transparency over tax and royalty payments from BP's huge Baku-Tbilisi-Ceyhan pipeline. BP is also investing in agricultural programmes to help local communities, and helping local companies to bid for contracts on the pipeline [19].
- National Grid Transco, a major distributor of electricity and gas in the UK, is using Aborigine workers on a project that is laying undersea cable from Melbourne to Tasmania [19].

Engineers can be encouraged by such shows of corporate social responsibility.

6.3 Balanced View

All engineers have responsibilities, but their prime responsibility is to 'safety'. They are bound by the legal system in their country of residence or operation, but also have to satisfy the following criteria in all aspects of their work:

- professional (institutional requirements);
- legal ('standard (or duty) of care'); and
- ethical (moral).

So… what can an engineer do to ensure he or she is behaving in an ethical manner, and for an ethical company?

The first thing to do is to understand your company's values. Are you working for a company that gives good, fair value? Or do they try and squeeze the biggest profit, and look for gullible customers? Do they have an ethics policy, and work to it? Does the company appreciate the wide responsibilities it has to all its stakeholders? Do you admire your bosses and colleagues for human values such as honesty, mentoring, intellect, hard work, wisdom, friendliness, fairness, etc., or is the only admiration in their position and salary?

Some companies are actively addressing staff concerns over ethical issues; for example, National Grid Transco, a major gas and electricity business in the UK, has consulted its 14,000 workforce and is working to a 'Framework for Responsible Business Practice' that provides details of its corporate responsibilities [19].

The next thing an engineer needs to do is check his/her own values in the workplace: integrity, honesty, charity, etc..

Consequently, an engineer has to balance all ethical issues and decide on participation on a career, job or project. This may not be easy; an engineer working for a company that makes missiles could view the missiles as a weapon that ensures equity and peace in the world, whereas communities destroyed by the weapon can only see it as it is – a weapon of mass destruction.

It is the same in the oil and gas business. The service sector in the pipeline business is often faced with 'difficult' decisions in pricing jobs, and winning contracts in some countries and some companies. These problems have been around for many years and gives some elements of the service sector a really chequered history. And do not think the oil and gas majors are without a chequered history. Anyone working for an oil and gas major who has never heard of the infamous ‘Seven Sisters’ should quickly type that phrase (and ‘oil’) into their search engine now….

6.4 Beware the Money Trap…

We can be driven to unethical acts, or ‘conflicts of interest’ by greed: we want more money. On January 2, 2000, the New York Times reported, *“Most partners [at] the world’s largest accounting firm violated rules prohibiting conflicts of interest by possessing investments in companies for which they performed ‘independent audits’.”* An estimated 86.5 percent of the 2,698 partners had at least one such violation, for a total of 8,064 cases.

Does money bring happiness? There is mounting, clear evidence that it does not [20, 21, 22]!

First consider what you ‘want’ and what you ‘need’. There is a big difference: when we see a sports car, or an expensive handbag, ‘desire’ takes over and the distinction is lost. We want the brief pleasurable moment of acquisition. In many ways, we now have an excess of everything, except happiness!

Most research supports the conclusion that money and material things are only weakly associated with leading a good life. As income rises, the sense of happiness (now usually called ‘wellbeing’) rises. But only to a point… once a ‘middle class’ level is reached, money is not linked to happiness. Conclusion? Needs can be satisfied, but ‘wants’ never can!

We NEED food, clothes, medical care, transport, etc.. Once you have attained these needs, you are satisfied. Unfortunately, the more you WANT, the more likely you are to feel disgruntled. We can identify with this: I ‘want’ Pamela Anderson, but I ‘need’ my wife!

The more you acquire, the more likely you are to feel controlled by your possessions; for example, if you buy an expensive car, you need money to run it, and this spending may affect your ‘needs’. Plus, you will be obsessed with any scratch on it!

Actually, these conclusions are not new; the Greek philosopher Epicurus believed that to be happy a person requires: food, water, shelter, warmth, friendship, and freedom of thought. He advocated a simple life. He believed we all have the capacity for a happy life, but we ‘poison’ our lives with needless anxieties and fears.

So… money, it turns out, is not the answer: once we have enough to pay for life's basics, such as food and a roof over our heads: more money adds little to our happiness. Therefore, do not sell your ethics!

6.5 What Turns an Ethical Person into an Unethical Person?

We will end by asking a question… *‘how can good, honest, ethical, people become unethical and dishonest in their work?* We are often surprised when we hear about individuals, who in their normal day-to-day lives are good and honest, but they have been shown to be the opposite in their professional lives.

There are many reasons why people act unethically at work: it could be based on greed (financial incentives), ambition, or envy. These people have a problem – they are inherently unethical, or easily corrupted and require help. Ethical people wake up in the morning, and they are ethical throughout their day, regardless of what they do during that day. These people have no problems with ethics: they are inherently ethical.

However, even the saints amongst us can behave unethically. Why? One reason is that people may fall under the ‘spell’ of a large corporation, and believe that actions that benefit the corporation, are ethical. Consider this extract from an article in the Economist in May 2004:

"… the corporation is a psychopath. Like all psychopaths, the firm is singularly self-interested: its purpose is to create wealth for its shareholders… like all psychopaths, the firm is irresponsible, because it puts others at risk to satisfy its profit-maximising goal, harming employees and customers, and damaging the environment.

The corporation manipulates everything. It is grandiose, always insisting that it is the best, or number one. It has no empathy, refuses to accept responsibility for its actions and feels no remorse. It relates to others only superficially, via make-believe versions of itself manufactured by public-relations consultants and marketing men. In short… the corporation is clinically insane…."

7. CONCLUSION

In a world where oil and gas is, and will be, extracted from poor and sometimes corrupt countries, where the fuels that pipelines transport lead to climate change, where the oil and gas majors continue to make record profits, and where litigation is increasing, pipeline engineers must practice to the highest ethical standards.

Our responsibilities and ethics will require constant attention: this paper has provided a simple guide.

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