Good Practice Guidelines

for

Engineering Managers

in the

Use of Computer Software in the Design of Process Plant

Management has the overall responsibility for developing appropriate standard procedures and practices and for ensuring that they are followed.

These Guidelines will continue to evolve and develop as our understanding of the issues and our experience of using existing and new tools and techniques develops. The Working Party therefore welcomes and encourages feedback from readers, both in general and on specific items (as noted in the text), regarding ways to make these Guidelines both better and more widely applicable.

Contents

Preface

Computers are now indispensable in the design and operation of process plant. The great benefits provided by today's computers to undertake extensive calculations bring with them the need to recognise that they are also capable of delivering wrong answers to high degrees of precision if care is not exercised.

The detection of such errors becomes correspondingly more difficult as the extent of computerized activity grows and the complexity of programs increases. Nevertheless, Chemical Engineers are subject to the provisions of the law, such as the Health and Safety at Work Act 1974, and must pay due attention to the implications of the decisions they make, whether or not they are based on the results of computer calculations.

The CAPE Subject Group of the IChemE therefore decided that the time had come to bring this guide up to date. The Working Party which produced the revised guide has attempted to condense more than 150 manyears of their own collective experience of computing in process design along with that of the numerous other contributors.

We hope that it will receive the widest possible dissemination and, moreover, by making this experience available, that at least some of the disasters that might have occurred may be averted.

Readers should note that we do not regard this as in any way a final edition and we welcome and look forward to feedback for use in the next edition.

Dr Rob Best, South Bank University
Chairman, Computer-Aided Process Engineering Subject Group

Scope

These guidelines contain suggestions for good practice to those who manage process engineers using computer software for the design of process plant.

Such usage is now widespread and the tools concerned include, for example, flowsheet simulators and equipment design programs.

The principal feature of these computer tools is that they are used in a decision support environment; computer tools can be used to provide information or even advice but, in all cases, a qualified engineer makes and is ultimately responsible for all design decisions.

The working party believes that, although the guidelines are primarily concerned with the use of computer programs, many of the suggestions are just as valid when dealing with the results of hand calculations.

Readers should note that these guidelines are in no way intended to modify or replace engineers' responsibility under the appropriate legislation (see below): these guidelines must be treated as suggestions and in the spirit of "necessary but not necessarily sufficient". ***The working party accepts no liability whatsoever for the use which may be made of them.***

Note

This document is an extract from:

Good Practice Guidelines

The Use of Computers
by
Chemical Engineers

Guidelines for practising engineers, engineering management, software developers and teachers of chemical engineering in the use of computer software in the design of process plant

A copy of the complete document may be downloaded free of charge from either of:

http://CAPE.icheme.org
http://CAPENET.chemeng.ucl.ac.uk

Copying

The Working Party intends that these Guidelines should have the widest possible circulation amongst practising engineers and we hope that the style of presentation will allow sections to be copied for use in documents used in training and for display above the desks of engineers and managers; we ask only that the source is acknowledged, the copyright notice is not removed and that, unless by prior consultation, they are reproduced without alteration. Companies and/or HEIs are welcome to incorporate these guidelines into their own procedures, again, subject to acknowledgement, etc.

Note, however:

- The materials in these Guidelines are copyright and reproduction in any form for the purposes of commercial gain is expressly forbidden
- These Guidelines will be updated from time to time and it is the *sole responsibility* of anyone making a copy to ensure that their copy is kept up to date by reference to the most recent public version.

Legal & Professional Implications

Within the UK the work of the chemical engineer is subject to the provisions of various Acts of Parliament, including the Health and Safety at Work Act 1974.

This Act has important consequences for the way we work, laying down a number of duties for employers and employees and making it a criminal offence to fail to discharge those duties. For an overview of the way in which the Act and other aspects of the law may impact upon the work of the chemical engineer, see Appendix A6.

Similar or equivalent legislation operates in other Countries and the implications are the same: you, the professional engineer, are responsible for all decisions which you make, whether or not a computer is involved.

Attention is also drawn to the Rules of Professional Conduct of the UK Institution of Chemical Engineers, an extract from which is included within Appendix A6.

Feedback & Comments

The Working Party welcomes and encourages feedback from readers, both in general and on specific items, regarding ways to make these Guidelines both better and more widely applicable.

Such feedback should be sent in the first instance to either:

CAPE Subject Group Officer
IChemE
165-189 Railway Terrace
Rugby
Warwickshire, CV21 3HQ

or:

The document editor: Tony Perris (Tony.Perris@btinternet.com or t.perris@ucl.ac.uk)

Guidelines
for
Engineering Managers

Modern engineering computer tools makes it very easy for engineers to appear to carry out very comprehensive design tasks when, in reality, they may not fully understand what they are doing. A glance at the previous chapter “Guidelines for Engineers Using Software” indicates just how easy it is to go wrong and what care must be taken and there are clear legal implications if a proper professional approach is not adopted (see Appendix A6).

For this reason, the use of such tools has to be managed very carefully, both by the individual engineer (as outlined in the previous Chapter) and by their line management, as set out below.

Management has the overall responsibility for developing appropriate standard procedures and practices and for ensuring that they are followed.

Engineering Experience

- the engineer assigned to a problem must fully understand that problem in engineering terms and be properly qualified both to assess the quality of any results produced by any computer tools which he/she may use and to justify the decisions being taken. The use of computer-aided design software is not a substitute for engineering expertise.
- the engineer must be able to justify the use of a particular modelling approach or computer tool and the data used for their specific problem.
- the experience of the engineer should reflect the level of manual checking which may be required. If a particular item is considered acceptable on the basis of “judgement” then that judgement must be based on real and relevant experience (where “real” experience implies feedback from real plants). Examples of the type of check that should be applied are shown in Checking the Results, Appendix A3.

Getting Help

- engineers should be made aware of the sources of information and user support services, both internal and external.

Training

- the engineer must be competent in modelling and in the use of the software and, where appropriate, understand any specific characteristics of the hardware platform. Formal training should be provided where necessary (see "Education and Training").

(... continued)

Software

- computer tools to be used in the design process should be carefully selected and subjected to thorough testing, validation and quality control. This is particularly important for software written to solve a particular problem (but then being applied more widely) or obtained from bulletin boards, shareware or other “informal sources”, all of which should be treated with extreme caution.
- company standard or other widely-used software must be properly supported and maintained, either by internal support services or by the software suppliers under an appropriate maintenance agreement. Support and maintenance personnel will require specialist skills and training (see "Model-Building, Programming and End-User Support").
- changes to standard or other widely-used software and upgrades to new versions must be carefully managed. Generally, the aim should be for consistency throughout the organisation, though there may be exceptional situations where the use of a non-standard version of a particular program may be justified for a particular project. Note, however, that:

    - these are **exceptions** and the use of such non-standard software must be **explicitly justified**
    - thorough testing and validation is still required **before** such use is authorised
    - such use (and the reasons for its authorisation) must be explicitly recorded in the audit trail

Networks

- the properly controlled use of computer networks can simplify the management process but, of course, the uncontrolled use of such networks, access to unofficial versions, shareware, etc, may raise serious problems.

Audit Trails

- in order to provide a formal audit trail showing who did what and when, records must be kept of computer calculations. Detailed suggestions are listed in “Keeping Records” in the earlier chapter for engineering users. Line management must ensure that a coherent system of managing this information is provided and that the system is used.
- records should especially be kept of the circumstances which have led to unexplained errors or failures (see "Guidelines for Developers and Supporters of Engineering Software"). Procedures for monitoring these records and for taking action where required should be established.

Good Managerial Practice

- engineers must never be put in a position where they are unable to comply with these or other guidelines intended to ensure the adoption of safe and professional working practices. If engineering management, for example, insist on the use of a particular program, they must ensure that it meets all the relevant guidelines in terms of quality, documentation, validation, aids to checking, etc, as outlined above and in other chapters of this document.

Appendix A6

Legal & Professional Aspects

It should be noted that there is, as yet, very little established precedent regarding the legal implications and liabilities associated with the use of software in engineering design activities. What follows, therefore, is necessarily a matter of opinion/judgement/interpretation on the part of the Working Party and input and suggestions from readers on potential enhancements to this Appendix would be welcomed.

1. Legal Aspects

The work of the chemical engineer in the UK is subject to the provisions of various Acts of Parliament, including the Health and Safety at Work Act 1974. This Act has important consequences for the way we work, laying down a number of duties for employers and employees and making it a criminal offence to fail to discharge those duties.

Some Points from the Act

- The duty is imposed on the individual, unless the individual can demonstrate that training or guidance from the employer is inadequate.

- If an employer's practice is faulty, or the individual is not adequately trained in good practice, then the employer would be held liable.

- If an individual is negligent, then it can result in criminal prosecution and/or being sued for damages through the civil court. Negligence implies a deliberate action done with knowledge, but ignorance would not be a defence if the individual was in a position of responsibility. A corporate body can equally be held to be criminally liable.

- Software which directly affects the operation of plant (eg. process control software or online optimiser) must be designed and constructed so as to be safe, adequately tested and supplied with adequate information to ensure that it is properly used.

- Penalties for breach of the Act are principally criminal (fines and custodial sentences).

- If an individual is injured following a breach of duty under the Act, liability will be deemed proven also.

Similar or equivalent legislation operates in other Countries and the implications are the same: you, the professional engineer, are responsible for all decisions which you make, whether or not a computer is involved.

Licensed Software

Note that software licences usually contain such broad-ranging exclusions and/or disclaimers as to be almost meaningless. It should also be noted, however, that the legal validity of such disclaimers is often unclear and may be subject to a judgement of what is and what is not considered to be "reasonable". Many licences almost certainly contain clauses which would be deemed "unreasonable exclusions" if challenged in court.

However, validation before use is often a critical issue, whether it is your own software or is licenced from a vendor. (Validation of your own developed software is covered in Appendix A5.) You would therefore be expected to take "reasonable steps" to validate the software for each of your intended applications, in order to establish "fitness for purpose" and the vendor would be expected to cooperate in a "reasonable" manner to facilitate this validation.

2. Professional Responsibilities

Most organisations will have established corporate standards and guidelines and, in general, it is your professional responsibility to take reasonable care to follow accepted good practice and your company's procedures. If you do not, you may be increasing your liability. It is therefore important to maintain records which show that you have: this is one reason for the emphasis placed on keeping records and the audit trail in the various chapters of these Guidelines.

The following is an extract from the UK IChemE's "Rules of Professional Conduct", Issue 2: October 1991:

> *"3. A member, when discharging his professional duties:*
>
> > *(a) shall satisfy himself as to the extent of those duties, and, if in doubt, obtain such clarification or confirmation as is necessary to satisfy himself as to their extent before entering upon them, and shall not accept professional obligations which he believes he has not sufficient competence or authority to perform;*
> >
> > *(b) shall accept due responsibility for all work done by him or under his direct supervision, and shall take all reasonable steps to ensure that persons working under his authority are competent to carry out the tasks assigned to them, and that they accept personal responsibility for work done under the authority delegated to them;*
> >
> > *(c) shall, when called upon to give an opinion in his professional capacity and based on the facts disclosed to him, give an opinion that is objective and reliable to the best of his ability; and*
> >
> > *(d) shall, if his professional advice is not accepted, take all reasonable steps to ensure that the person over-ruling or neglecting his advice is aware of the possible danger which he believes may result from such over-ruling or neglect.*
>
> *4. A member shall take all reasonable care in his work to minimise the risk of death, injury, or ill-health to any person, or of damage to property. In his work, a member shall respect all laws and statutory regulations applicable to the design, operation and maintenance of chemical and processing plant. In addition, a member shall have due regard for the need to protect working and living environments, and the need to ensure efficient use of natural raw materials and resources."*