Safe in Their Hands?
Licensing and Competence Assurance for Safety-Critical Roles in High Risk Industries

Report for the Department of Health

Rhona Flin

Industrial Psychology Research Centre
University of Aberdeen

Final version: October 2005

Contact: Professor Rhona Flin, School of Psychology, University of Aberdeen, King's College, Old Aberdeen AB242UB. 01224 272341, email: r.flin@abdn.ac.uk

Acknowledgements: With thanks to Dr Steven Yule for conducting the literature search and to the managers and regulators who were interviewed for this report.

Industrial Psychology Research Centre

Project: DoH 0160096	**Date**: 17 /10/2005
Assessing job performance in safety-critical roles in high risk industries	

CONTENTS

Licensing and Competence Assurance in High Risk Industries

EXECUTIVE SUMMARY

A review is being undertaken by the Department of Health (England & Wales) of the issues arising from Dame Janet Smith's (2004) *Shipman Inquiry: Fifth Report*. These include clinical governance, the role of the GMC, revalidation and appraisal of doctors. In relation to the future design of medical regulation, the Department of Health decided to look beyond health care and to consider the approaches taken in industry to maintain and assure professional standards of job performance, to meet regulatory standards. This report prepared by Professor Rhona Flin, University of Aberdeen describes the licensing, competence assurance and revalidation procedures for one safety-critical role in each of three high-risk industries: aviation, nuclear power and offshore oil production. The selected occupations were pilots in civil aviation (regulator CAA), unit desk engineers on nuclear power plants (regulator NII, HSE) and offshore oil managers (regulator OSD, HSE). A literature search revealed a very limited number of publications on performance assessment for these occupations. Interviews were conducted with representatives from operating companies and the regulator in each sector to determine the current regulations and procedures for the assurance of performance competence in each case.

The level of regulation was highest in aviation where a full licensing programme operated by the regulator (CAA) is in place. Pilots are subject to performance checks every six months, with annual licence checks. One of the notable features of this regime is not only the systems in place for regular training and assessment of licence holders but also the assurance procedures used to check the competence of the authorised examiners. For the oil and nuclear power sectors, the regulator (HSE) adopts a goal setting, safety case regime. The companies implement their own competence assurance systems which include regular performance checks. In the case of unit desk engineers in the nuclear industry, the formal assessments to revalidate their authorisation take place every two years. The three systems are described with key features extracted and possible applications for health care considered.

Licensing and Competence Assurance in High Risk Industries

1. <u>Introduction</u>

The issue of doctors' fitness to practice and associated management practices has been debated within the profession for a number of years (Donaldson, 1994; Rosenthal, 1991). But with increasing concern regarding patient safety in the NHS (Department of Health, 2001; Vincent et al, 2001), the regulation of medical and other health care practitioners has now become a topic of considerable public interest (Catto, 2005). In some countries, doctors are licensed (Dauphinee, 2005) and there can be additional mandatory accreditation relating to certain safety-critical skills.[1]

The recent Shipman case and consequent Inquiry have served to raise awareness of the level of regulation currently in place to govern the quality of medical practice in UK. A review is being undertaken by the Department of Health (England & Wales) of the issues arising from Dame Janet Smith's (2004) report *Safeguarding Patients: Lessons from the Past - Proposals for the Future. Shipman Inquiry: Fifth Report*. These include clinical governance, the role of the GMC, revalidation and appraisal of doctors. The Chief Medical Officer (Sir Liam Donaldson) established a working party on this subject and requested a set of reports to inform their deliberations. In relation to the future design of medical regulation, it was decided to look beyond the health care professions and to consider the approaches taken in industry to maintain and assure professional standards of job performance, to meet regulatory standards. The Department of Health commissioned Professor Rhona Flin, Industrial Psychology Research Centre, University of Aberdeen (May 2005) to prepare a report describing how industries from three high risk industrial sectors in the UK issue and revalidate licences or authorisations for personnel in safety critical positions. (The term high-risk is used in relation to the types of hazard inherent in the operations of these industries (i.e. the level of consequence for a serious adverse event) rather than to suggest inadequate risk management capabilities). The methods of data collection were a) a literature search and b) an interview study.

[1] e.g. in Pittsburgh USA, anaesthesiologists have to pass 'difficult airway management' courses every two years.

2. Literature Review

A literature search was conducted to establish what had been published on licensing/ revalidation issues for the target occupations within the academic and professional literature. The following databases were accessed through ATHENS: BIDS IBSS, Web-of-Knowledge, EDINA BIOSIS, EBSCO HOST (incl. psycINFO, psycArticles, Econlit), PsychLit, Emerald, and ScienceDirect. The following general and specific search terms were used:

i General search: Licensing, revalidation, competence assurance, qualification, skills assessment, commercial licence, performance review, re-authorisation.

ii Civil aviation: CAP737, Operator's proficiency check, licence check, confidential reporting.

iii Nuclear power: Site licence, desk engineer, duly authorised person, DAP, suitably qualified and experienced, SQEP, simulator examination, authorisation interview, simulator assessment.

iv Offshore Oil: Offshore safety, OIM competence.

The criteria for inclusion in this review were: i) addresses licensing or revalidation issues for personnel in civil aviation (pilots), nuclear power (Duly Authorised Person - DAP) or offshore oil production (Offshore Installation Manager – OIM), ii) published in English, iii) published between 1951 and 2005.

This search revealed very few articles in the retrieved literature regarding revalidation and licensing issues in the three industries under scrutiny in this report. Several papers addressed the role of the Civil Aviation Authority (CAA) in aerospace safety and made reference to human factors issues, but did not directly assess revalidation of pilots' skills, so were rejected for this review. Similarly, a number of articles looked at site licences for nuclear power stations but did not mention the role of the DAP. In offshore oil, one relevant article was found. Slaven (1995) outlined a competence framework used by an oil company to assess OIMs managerial competencies. This includes 17 output and 23 input competencies on which OIMs are assessed using a questionnaire. Slaven reports that the system is used to assess prospective job candidates, as well as appraise current post holders and aid training. (OIM competence assessment is discussed below in section 4.3 on the oil industry). Most of the source material on the actual licensing regulations or organisational practices appears to be in industry or regulatory publications (often located on web sites).

The literature search did return numerous articles on licensing and revalidation for other professions, and there are general texts on the subject of competence assessment (e.g. Fletcher, 2000). There is a substantial literature on licensing issues in government, driving, food, healthcare and there is statutory certification in the UK for certain positions, e.g. Maritime and Coastguard Agency (www.mcga.gov.uk) issues and revalidates mariners' certificates of competency. The Health and Safety Executive (HSE) deal with certification of mines managers and diving supervisors.[2]

One relevant document identified (from one of the interviews) was the report commissioned by the HSE on competence assessment for hazardous industries with particular reference to emergency management (Wright, Turner & Horbury, 2003). It explains that with the introduction of the Control of Major Accident Hazard Regulations (COMAH, 1999), it is no longer acceptable for COMAH duty holders to make untested assumptions about staff competence. Duty holders are now required to put in place a competence assurance system that includes competence standards, assessment and reassessment. The regulator also requires a specific link between identified safety critical tasks, roles, responsibilities and a comprehensive management system. The safety case legislation discussed later places similar responsibilities on duty holders. Wright et al (2003) reviewed current practice in several high hazard industries: (chemicals, aviation, offshore and nuclear) with regard to major accident prevention. They noted that competence assessment in these industries was conducted as part of a cohesive, planned and managed process, linked to risk assessment. The assessment of competence in safety critical roles mirrored the approach advocated for competence assessment in general, with regard to collecting evidence, setting out performance criteria, having standards documenting key knowledge and skills (including non-technical), and the use of independent, credible and competent assessors. Other relevant literature identified from the interviews is mentioned in the text to follow and listed in the reference list.

3. Case Reports : Method

Three high risk industries operating in the UK were selected: civil aviation, nuclear power generation, offshore oil production). These employ staff in safety critical positions with responsibility for a large number of workers on their production sites (oil industry) or who have responsibility for passenger or public safety (aviation and nuclear power). In each sector, a sample occupation was selected. Face to face interviews were conducted (June - September 2005) with representatives from the regulatory authority and from one or more operating companies in each sector to discuss licensing/ authorisation procedures (In one case, a telephone interview was carried out). A semi-structured format was used: see Appendix 1 for the interview schedule. Notes taken during each interview were written into a summary that was subsequently checked by the interviewee for accuracy. The relevant legislation was consulted and in some cases, company or internal regulatory documents were provided for additional guidance. The resulting descriptions are presented as three separate industrial case reports.

[2] www.hse.gov.uk/mining/coalqual/index.htm
www.imca.int.com/divisions/diving/profile/personnel/certification.html

4. Industrial Case Reports

4.1 Civil Aviation

Interviews were conducted with Captain Peter Griffiths (Flight Operation Standards, Civil Aviation Authority), Captain Paul Quick (Training and Standards Manager, Bristow Helicopters), Captain David Lerche, Standards Captain, (British Airways). Captain Paul Field (British Airways) provided additional material on non-technical skills.

4.1.1 The Civil Aviation Regulator

The international civil aviation industry has very well developed competence assurance systems based on training, qualifications and licensing for pilots and aviation engineers. This originated from the International Civil Aviation Organisation (ICAO) Chicago convention in 1944, where the standards expected in national aviation regulations were established. Their philosophy is now enacted through the regulations established by each country. In the UK, the Civil Aviation Authority (CAA) establishes and monitors the regulations (Air Navigation Order) for civil aviation and these are designed in the main to harmonise with the European aviation requirements produced by the Joint Aviation Authorities (JAA)[3]. The focus in this case report will be commercial pilots, of whom there are approximately 17,000 licensed in the UK.

The CAA issue operating licences to the air operators (e.g. airlines such as British Airways or easyJet), employing the pilots. These operating companies are required to adhere to certain standards from the regulations and the CAA is responsible for monitoring their compliance by assessing their safety systems, using various inspection methods, including audits, spot checks and ramp checks (to ensure pilots' licences/ medical approvals are 'in date'). Different levels of oversight can be applied to an operator. The operator does not have to have a formal safety management system but this is encouraged.

The CAA (Personnel Licensing Department) governs the system of pilot licensing and revalidation, although some elements of this can be devolved to the operators. A very rigorous sequence of training and qualification must be accomplished before pilots are granted commercial licences for specific types of aircraft and particular flight operations (see LASOR for licensing regulations on CAA website). Thereafter they must fly a minimum prescribed number of hours in a given period and must undergo recurrent training, as well as checking. The latter includes recurrent flight training and recurrent Crew Resource Management training (3 year rolling programme involving simulator and classroom). The requirements will depend on the specific type of operation their company undertakes (e.g. flying at high altitude, carrying dangerous goods). For instance, North Sea helicopter pilots have an annual test of 'Night Deck Recency' to check competence in handling a night approach, landing and take-off from an offshore location (e.g. an oil platform or vessel).

4.1.2 The Pilot's Licence

Pilots must hold a current licence including a rating for a given type of aircraft before they will be permitted by an air operator to fly the company's planes. The licence is valid for five years but each aircraft rating must be revalidated every year and is signed by a CAA approved licence examiner. Pilots are also required to pass regular medical checks (frequency depending on age) with fitness to fly certified by a CAA approved medical examiner (AME). Most air operators have drug and alcohol policies permitting random testing. There are also rules governing retirement, and the age (60 years) at which pilots with certain types of licences cannot fly alone or must fly with a younger pilot. Different countries may have different age regulations for pilots flying across their air space. Typically fixed wing pilots retire around 55 years, helicopter pilots around 58 years.

<u>The Licence Examiners</u>

The ratings within a licence can only be awarded or re-validated by a Type Rating Examiner (TRE). This is a licensed pilot, with current flight experience, who has been

[3] European Aviation Safety Agency, EASA from 2005

appointed by the CAA (and is effectively working for the CAA when conducting type rating assessments). The TRE may be a pilot within the same airline as the candidate.

To become a TRE, a pilot must have a certain amount of relevant flying experience, have completed an approved TRE course (at CAA or in-house in some of the larger airlines) and have passed a TRE assessment test with a CAA Examiner. A pre-requisite for appointment is that the pilot must already have completed an approved training course and assessment test as a Type Rating Instructor (TRI). Because of the importance now placed on pilots' non-technical skills (e.g. decision making, leadership), the CAA mandated in 2004 that all TREs must be not only be qualified as a technical instructor, but must also be qualified as an instructor in Crew Resource Management (CRM-I) to teach non-technical skills. (See RAeS, 1988; CAA 2003). Non-technical skills are discussed in Appendix 2.

The TREs have their instructor rating examiner's authorisation revalidated every three years. This is carried out by a RETRE (Revalidation Examiner of TRE) who is effectively a higher level TRE (but does not have the authority to conduct the initial assessment of TREs). The RETREs are appointed by the CAA, provided they meet certain standards of flying, instructing and examining experience, then they must attend a two-day course at CAA before they are approved. Their appointments have to be revalidated by CAA every three years. The CAA hold a two day 'Validation Conference' every year for RETREs, which they are expected to attend. This provides valuable feedback on the operation of current licensing and revalidation procedures for the regulator.

<u>The Competence Checks</u>

Commercial pilots are subject to competence checks every six months. There are many kinds of check governed by different JAA legislation. The main checks of operating competence are the Operator's Proficiency Check, Licence Proficiency Check and the Line Check.

The *Operator's Proficiency Check* (OPC) is carried out by the operator using a TRE. This is a six monthly company check of the pilot's competency in handling normal, abnormal and emergency procedures under both visual and instrument flying conditions for the company's licensed flight operations. The relevant requirements can be found in JAR-OPS. There are a number of prescribed manoeuvres that are tested (e.g. engine failure on take off) and these checks are normally carried out in a CAA-approved, full-fidelity aircraft simulator. This could involve a crew of two pilots who are both being checked, taking turns as pilot flying, each having to demonstrate competence in all the prescribed manoeuvres. The pilot's non-technical skills are checked as well as the technical skills but a fail decision is not normally recorded for non-technical skills alone, i.e. there must also be a technical failure. This might involve two simulator sessions of five hours in total. A company OPC form will be completed by the TRE and stored in company records.

The *Line Check* is carried out by operators conducting commercial air transport flights using a Line Training Captain (appointed as an assessor by the company using a procedure acceptable to CAA), who must also be qualified as a CRM-Instructor (CRM-I). This is an annual check (also governed by JAR-OPS requirements) that is usually undertaken on a normal public transport flight and assesses the pilot's competence in handling the procedures and conditions required for that flight segment. The pilots' CRM/ non-technical skills are also scrutinised during this check.

The *Licence Proficiency Check* (LPC) is the annual licence revalidation check by a TRE that is usually undertaken on an aircraft or on approved simulator. (The term renewal refers to the check required when a licence has expired). (Relevant requirements can be found in JAR-FCL or the CAA Standards document, see LASORS 2005). It assesses the pilot's competence in handling normal, abnormal and emergency procedures under both visual and instrument flying conditions for the type of aircraft for which the pilot is licensed. In practice, non-technical skills (e.g. decision making, crew co-ordination) are also checked for pilots flying multi-crew aircraft. There are a number of prescribed manoeuvres that are tested (e.g. engine failure on take off). This will take between two to five hours depending on whether the check is conducted in the aircraft, simulator, or a combination of both. At the end of the check, the TRE completes a CAA LPC form, part of which is returned to the CAA, and the other part retained by the TRE.

In practice, the Operator's Proficiency Check and the Licence Proficiency Check may be undertaken by the same TRE during one test session. The content of both checks is similar, but the OPC may contain additional elements related to the type of operation conducted (e.g. offshore operation specific manoeuvres).

If a pilot fails a check (and this is not a frequent occurrence), then she or he will not be allowed to fly and will be referred for retraining and will require to be checked again, usually by a different TRE. Pilots who experience a full failure will have their loss of licence privileges explained to them, as well as the training they will be required to undertake. For a partial or marginal fail, (e.g. an error with no effect on flight safety) then the TRE might decide to re-test the failed items during the same session.

4.1.3 Other performance monitoring systems in aviation

The air operators and the regulator rely on a number of additional performance monitoring tools. For instance, the aviation industry has Mandatory Occurrence Reporting - a compulsory reporting of specified incidents, producing a database identifying common latent conditions (CAA CAP 382). This was mandated across the EU in July 2005. In addition, Confidential Reporting systems for pilots are well established on a national basis (CHIRP www.chirp.co.uk funded by but distanced from the regulator) and some of the larger operators may have in-house versions. These could detect performance, behavioural or well being issues for a given pilot, although this is not their principal purpose, which is to produce Feedback Reports to the industry with common or emerging problems.

Many airlines now routinely use Operational Flight Data Monitoring to examine the technical parameters of each flight using the information from the flight recorders. This is carried out on a non-prejudicial basis. Should a flight be shown to have been operated out with significant deviations from normal parameters, then the pilots can be interviewed to discover why this occurred. Some companies also use LOSA (Line Oriented Flight Audits) where approved observers fly on a number of flights on a particular fleet and write a report to management focussing on the threats to safety and observed errors (Helmreich, 2002). This usually examines crew rather than individual performance but can provide additional information on standards of behaviour during these observations.

4.1.4 Key features: aviation industry

- The regulator (CAA) manages a long-established, international system of pilot licensing and revalidation for particular types of aircraft and specific operating conditions. Separate regulations govern flight crew licences and flight operations. Licence checks are generally carried out in the companies by CAA-approved examiners.

- Pilots have a competency check every six months - where their flying skills are observed and rated. There is an annual licence check, also involving a rating of observed task performance.

- Standards of performance are clearly stipulated and are the foundation for training and assessment.

- Rigorous systems of training and accreditation are applied for performance assessors.

- The focus is on non-technical (cognitive and social) skills, as well as technical.

- High-fidelity simulators are used for parts of the evaluation process.

- A range of safety monitoring systems is in place which complements and strengthens competence assurance mechanisms

4. 2 Nuclear Power Industry

Interviews were conducted with Dr Craig Reiersen, Ms Jane Bowie and Mr Terry Taylor (Human Factors Assessors, Nuclear Installations Inspectorate, Health and Safety Executive) and Mr Steve Belton (Nuclear Oversight Assessor, British Energy) and Mr Clive Shaw (Training Standards Team, British Energy).

4.2.1 The Nuclear Regulator

Nuclear power and weapons sites in the UK are licensed and regulated by the Nuclear Installations Inspectorate (NII)/ Nuclear Safety Directorate on behalf of the Health and Safety Executive. In accordance with the Nuclear Installations Act 1965, the NII issue site licences which permit operators to generate nuclear power or to produce nuclear weapons, in accordance with carefully established and monitored conditions. (Schedule 1 of the site licence refers to specific technical conditions for that site; Schedule 2 is common to all UK nuclear licensed sites and consists of 36 conditions, two of these (12, 26) relate to personnel competence (see Appendix 3)). Licence condition 12 requires that each person who carries out activities which may affect the safety of operations on a nuclear site must be a 'Suitably Qualified and Experienced Person' (SQEP). For some jobs involving the control and supervision of operations which may affect safety, the post holder has to be a Duly Authorised Person (DAP).

The current regulatory regime adopts a goal-setting, rather than a prescriptive approach, and therefore the operator is empowered to design systems and procedures to meet the goals set by the regulator. A competence – based, systematic approach to training and assessment is advised. The NII concurs with the International Atomic Energy Authority definition of competence, "the ability to put skills and knowledge into practice in order to perform a job in an effective and efficient manner to an established standard." (IAEA, 1996). These competencies will include both technical elements and non-technical, such as management, leadership, communication. The NII regard the assessment of trainees and subsequently the periodic re-assessment of personnel as a key element in the process of developing and maintaining the competencies to be a SQEP or DAP. The licensee may use a range of different assessment methods but should be able to demonstrate to the NII that the method is valid, objective, and reliable. The NII (2004) emphasise that assessment should not be a one-off activity, pointing out that a person's competence may change over time, influenced by factors such as frequency of task execution, variations in circumstances or equipment for a given task, loss of memory for the task, development of bad habits and use of short cuts. Periodicity of re-assessment should depend on safety significance of the tasks, frequency with which they are performed, nature of the task (and inherent likelihood of loss of competence), operational experience feedback, compliance with standards.

The NII have approximately 170 inspectors, both specialist inspectors and site inspectors, the latter allocated to a particular installation where they will spend approximately a week of every month on site. (There are inspectors who specialise in human factors, as well as technical specialists). The inspectors have full site access and have legal warrants to enforce this if necessary. The NII will, as part of their inspection role, scrutinise the arrangements an operator has in place for making these assessments and authorisations. They will examine samples of the licensee's job analyses, training procedures and internal guidance documentation to determine whether the quality of training and reliability of assessment methods are meeting the required standards. The recommended 'Systematic Approach to Training' (IAEA 1996) incorporates task analysis, competence standards, evaluation of training effectiveness, as well as the design of training and assessment of trainees. A strong emphasis is placed by the NII on training, which should support the safety culture of the organisation and inculcate the right safety attitudes, as well as informing staff about safety management systems. Training should .. 'increase the degree of compliance with safe procedures, self-monitoring, the reporting of potential hazards outside the individual's responsibility, and all the other components of a 'culture of safety'' (ACSNI, 1990).

While the Inspector's role is to check the implementation of arrangements in place to meet the site licence conditions, should a Site Inspector have any concern regarding a member of the control room team's fitness to operate the plant or to supervise operations, then this would be raised with the site management.

4.2.2 Unit Desk Engineers

The occupation selected for examination in this case report is the Unit Desk Engineer who works in the control room of a nuclear power installation, operating the plant control system for one reactor/ generator unit. British Energy operate eight nuclear power plants and employ around 200 Unit Desk Engineers. Each control room shift will normally have on duty two Unit Desk Engineers (one per reactor/ generator unit), supervised by a Control Room Supervisor, overseen by a Shift Charge Engineer. Unit Desk Engineers undergo a rigorous training programme taking 18 months to complete (involving prerequisite entry qualifications, classroom training, simulator training and observations) before their competence to operate a control desk will be formally assessed.

<u>Duly Authorised Person</u>

In the UK, the nuclear regulator does not issue licences to the Unit Desk Engineers or other plant operations personnel. (They are licensed by the regulator in some other countries e.g. USA and Canada). The Unit Desk Engineer has to be first shown to be a 'Suitably, Qualified and Experienced Person' (SQEP) based on the company's own training and development programmes (licence condition 12.1). To be allowed to operate a reactor desk, the Unit Desk Engineer has to pass the specialist training programme, then will have his or her competence assessed based on observed performance while operating the reactor desk on the full fidelity simulator for three scenarios. The assessment will be made by the simulator tutor, the Shift Charge Engineer (SCE) and a second independent assessor (e.g. another SQEP such as a SCE), using a specially designed performance rating form which covers both technical, as well as non-technical skills (e.g. situation awareness, decision taking, co-operation) as in aviation. General guidance on simulator training and assessment is available in both company documents and material from the international nuclear bodies (e.g. IAEA 1996). The scenario events used for training and assessment will be based on probabilistic risk assessments and related safety data.

If the simulator examination is passed, then the candidate attends a Formal Authorisation interview to determine whether he or she can become a Duly Authorised Person (DAP) (licence condition 12.2). This will last for about 40 minutes and the candidate will be questioned by the panel, typically comprising the Plant Manager, a Shift Charge Engineer and the Head of Nuclear Safety Group (reactor physicist). The interview is designed to confirm that the Unit Desk Engineer understands his or her responsibilities and will be competent to operate the reactor safely. If the panel members are satisfied that the candidate is competent to operate the plant in a safe manner, then authorisation will be granted for a period of two years for one particular site. A newly authorised Unit Desk Engineer will undertake further on-the-job training and will be closely supervised before operating a unit independently. The Control Room Supervisors and the Shift Charge Engineers are also required to undertake simulator-based and interview assessments to maintain their DAP status. (These focus more on supervisory and managerial responsibilities). Line managers and simulator tutors are required to 'continuously monitor individual and team performance both on the Simulator and in the work place'. If any issues relating to performance shortfalls are observed, then these have to be discussed with the Operations manager and the necessary retraining/ reassessment organised. (British Energy, 'Conduct of Simulator Assessments', 2002).

As part of the operating company's management system, staff will also be involved in annual job appraisals with their line managers, these can include 360 degree and upward appraisals. In addition, they complete an annual self-report questionnaire on occupational stress.

<u>Re-Authorisation</u>

During the two year authorisation period, the engineer will work as part of the control room team and will undertake annual simulator training, as part of their continuing training. At the end of the authorisation period, the Unit Desk Engineer is required to undergo a formal simulator assessment and to be re-interviewed by the authorisation panel. If a Unit Desk Engineer does not pass the simulator check or the authorisation panel was not satisfied, then he or she will be referred for further training and assessment.

If a Unit Desk Engineer is involved in a plant incident which may be related to his or her actions, then their DAP status can be revoked until further investigation is completed.

They are not subjected to routine medical examinations, unless they are 'film badge holders' (Classified Radiation Workers) who spend time on the plant. British Energy has a drug and alcohol policy permitting random testing.

4.2.3 Other performance monitoring in the nuclear industry

British Energy, in common with other nuclear power companies (see Misumi, Wilpert & Miller, 1999), employs a wide range of safety management techniques such as independent peer reviews, safety audits, Probabilistic Risk Assessments, Reverse Briefing, Task Observation by managers, Human Error Tools.

4.2.4 Key features: nuclear power industry

- No formal licensing of operational personnel by the regulator (HSE) - licences issued to companies (duty holders) to operate sites.
- Responsibility for designing and implementing competence assurance systems for safety-critical roles (e.g. unit desk engineer) devolved to operator.
- Unit Desk Engineers undergo a formal competence check involving an observed performance rating in the simulator and an interview every two years.
- Competence assessment and authorisations are embedded in the organisations' safety management systems, linked to task analyses and risk calculations.
- Formal system of authorisation and regular revalidation (every two years) for unit desk engineers.
- Focus on non-technical skills, as well as technical.
- High fidelity simulators used for parts of the assessment.
- Range of safety and job performance monitoring systems in place which complement and strengthen competence assurance mechanisms

4.3 Offshore Oil Industry

Interviews were conducted with Mr Taf Powell (Head of Offshore Division, Health and Safety Executive), Mr David Street (UKSC Operations Resource Manager, bp) and Mr David Nixon (Safety Department, Shell Europe).

4.3.1 The Offshore Industry Regulator

The UK offshore oil and gas exploration and production industry is regulated by the Offshore Safety Division, part of the Hazardous Industries Directorate of the HSE. Following the Report of Lord Cullen's Inquiry (1990) into the loss of the Piper Alpha platform in 1988, responsibility for offshore safety was transferred from the Department of Energy to the newly created Offshore Safety Division of the HSE. Their regulatory approach (Offshore Installations (Safety Case) Regulations 1992) is not prescriptive and is instead based on a goal-setting regime, akin to that of the UK nuclear regulator (NII) and the Norwegian offshore oil industry regulator. Thus there is no statutory scheme for the certification of staff in safety-critical positions, although there are clear legal duties for employers (Duty Holders) to assure competency of these staff. The statutory provision requires companies to submit a safety case documenting identified risks and safety management systems for each of their offshore installations to the HSE for approval. A safety case will include information on the competence assurance systems in place for safety-critical positions on the installations. As well as assessing submitted safety cases, the HSE OSD Inspectors (currently 128), make regular site inspection visits to each offshore installation, they not only examine technical matters but can also include observations of staff in safety critical positions.

Each offshore installation (production platform, drilling rig or other vessel) has a site manager on duty, known as the Offshore Installation Manager (OIM). The OIM is responsible for the safe operation of an installation that may have 100 or more crew on board. As the Piper Alpha disaster with 167 fatalities demonstrated, this manager may also have to take the role of the incident commander should an offshore emergency (e.g. fire, explosion, capsize) arise. Following Lord Cullen's Inquiry, the oil industry began to develop more rigorous competence standards and assurance programmes for staff in safety-critical positions, such as OIMs and Control Room Operators. The OIM is taken as the focus of this report. There are approximately 250 OIMs currently working in the UK.

4.3. 2 The Offshore Installation Manager: Competence Assurance Systems

The regulator (HSE, OSD) considered statutory certification for OIMs (as per managers of mines in the UK) but given the shift from prescriptive legislation, it was decided not to introduce this. With the regulatory goal-setting approach, companies employing OIMs (normally operating or drilling companies) can adopt their own methods for their competence assurance programmes. The two oil companies visited both had developed detailed standards of competence for OIMs (as well as for other safety critical roles), based on task analysis and risk assessment procedures. Their standards and competence assurance documentation was very comprehensive; covering selection, training, assessment requirements (e.g. prerequisites, format, assessor, verifier and assessment frequency), maintenance of competence and transferability between work sites (installations). They also have site specific requirements, relating to the particular operations and hazards to be managed on a given installation. These job competence standards have to be met prior to appointment or within a prescribed time period (for non safety-critical competencies). In the case of certain 'underpinning knowledge' (e.g. well control systems), there may be a requirement for regular retraining and assessment. In bp, they also use computer-based ‘Competencies on Line’ which is a self-assessment software tool. All staff are required to self assess on a regular basis, with their ratings reviewed by their line manager. The system is designed to encourage self-reflection and can be incorporated into mid-year appraisals. Like bp, Shell is now making more use of self-appraisal of performance on computer-based systems, as well as peer review.

For some competencies, depending on level of activity and criticality, regular re-training and assessment are required. For instance, in addition to normal management duties, an OIM may have to take command during an offshore emergency. Non-mandatory, industry guidelines are available for the required training and evaluation

(UKOOA, 2004) and there are national occupational competence standards on 'controlling emergencies' for this role (OPITO: Offshore Petroleum Industry Training Organisation). The guidelines state that OIMs in post should participate in one exercise every year and at least every three years, participate in an exercise without any briefing as to the content and with feedback on their performance from a trained, independent observer. Regular emergency exercises and drills are run on the offshore installations by all companies. In Shell, the OIMs have an annual peer assessment during these events, as advised in the UKOOA guidelines. Competence in emergency management is assessed in bp by sending the OIMs every 3 years, to a specialist centre (RGIT Montrose) where they will have to demonstrate their ability to manage three emergency scenarios in a simulated offshore environment. Accredited independent assessors, as well as a company representative, undertake the formal assessment. Should an OIM fail the emergency management assessment, he or she would be referred for further training and reassessed.

Oil companies have regular performance reviews for staff against agreed targets (performance contracts), in some cases monthly, as well as annual appraisals. The latter could include upward or 360-degree ratings, as well as those from the direct supervisor, and a range of appraisal instruments are available. For instance, Shell have developed an upward appraisal tool which focuses on safety leadership behaviours – now established as a web-based system and this can be used as part of their appraisal process.

In both companies, some assessors and verifiers may be trained to national standards (A1, A2,V1,V2) for workplace competence assessment.

Staff in the oil industry receive regular medical checks, and there may be particular fitness assessments related to travelling and working offshore. Companies also have policies covering drug and alcohol testing (random or with cause).

4.3.3 Other performance monitoring systems in the oil industry

As in the nuclear power and civil aviation industries, the oil companies employ a wide range of risk monitoring and management techniques to maintain a high level of awareness of the state of safety on their installations. They have regular audits, typically using independent assessors from other parts of the organisation. Staff surveys are conducted regularly, some of which may concentrate on particular facets of organisational culture, such as safety climate and confidence in leadership. These can be analysed to reveal ongoing problems or levels of staff dissatisfaction in a given department that may relate to the performance deficits in key individuals.

Oil companies devote significant resources to the assessment of risk, employing various hazard analysis techniques (this is required for the safety case) and safety management tools. Incidents and accidents are studied very carefully, with incident potential matrices that plot frequency of event against possible consequence, used to determine the level of scrutiny to be adopted. Such techniques help to maintain current knowledge not only of technical protection to maintain safety but also of changing requirements in staff competence to meet task demands.

4.3.4. Key features: offshore oil industry

- Regulator (HSE) authorises operation of an offshore installation by accepting a company's safety case for that site. No licences are issued by the regulator for personnel (diving and marine regulations excepted). Responsibility for competence assurance of safety-critical roles (e.g. OIM) devolved to operator.
- Competence assessment and authorisations are embedded in the organisations' safety management systems, linked to task analyses and risk calculations.
- Formal systems of authorisation and regular revalidation of OIMs vary between companies but there is general adherence to industry guidelines. In one company, OIMs have to take command of an offshore emergency in an onshore simulator and their performance is rated by two assessors (on a three yearly basis).
- Simulators used by some companies for parts of the assessment.
- Range of safety monitoring systems, as well as job performance tracking measures in place to complement and strengthen competence assurance mechanisms.

5. Discussion

5.1 Caveats

Before attempting to extract general principles from the above cases, that might have application to health care organisations, several caveats should be stated.

First, professionals from industries such as energy or aviation, are working in a different commercial **culture** to that of NHS health care. This brings financial and production pressures but also significant resources when profits are high. Sub-standard performance usually has commercial implications, hence quality assurance programmes have a high priority. There may also be differences in organizational safety culture between high risk industries and the NHS (Dept. of Health, 2001).

Secondly, the companies operating in these sectors have distinct organisational structures, with reporting relationships, accountabilities and responsibilities clearly defined. They have **strong managerial hierarchies** with well-established traditions of performance monitoring and evaluation. This contrasts with the medical profession where doctors, especially consultants, do not always see themselves as part of a managed hierarchy. Formal reporting lines can be blurred or ignored and medical leadership power may be distributed in informal, rather than formal social networks (Flin & Yule, 2004).

Thirdly, in high-risk industries, sub-standard performance or deviant behaviours can have immediate and **life-threatening consequences for co-workers** and are therefore unlikely to be tolerated. In health care, it is normally the patient who is at risk from failures in competence rather than the work team.

Fourthly, the **populations** of professionals in the three specialist groups studied are much smaller than the number of doctors registered in the UK.

Fifthly, many of the technical operations (tasks) on flight decks, nuclear power plants and offshore oil platforms are governed by **standard operating procedures** relating to equipment or company procedures. Standardised procedures are less common in health care, where the value and application of evidence-based clinical practice guidelines is still the subject of debate (Timmermans & Berg, 2003).

5.2 General Principles

From reviewing the regulations and procedures adopted for competence assessment in the three industries sampled, nine general principles were extracted that might be worthy of consideration for licensing and revalidation in health care professions. The costs involved in implementing a competence assessment system are discussed in the following section.

i. Independent Regulator

In each of the industries sampled, the award and revalidation of individual licences or of licences to operate sites is managed by an independent regulatory body, namely the Health and Safety Executive for nuclear and oil industries and the Civil Aviation Authority for the aviation industry.

ii. Regular, formal proficiency checks

In the three industrial sectors sampled, the level of regulation was highest in aviation where a full licensing programme for pilots, governed by the regulator (CAA), is in place. Pilots have their **proficiency formally checked by observed task performance** every six months and their licences are revalidated on an annual basis. In the nuclear industry, the unit desk engineers are 'Duly Authorised Persons' and to maintain this accreditation, they have their competence at operating the unit under a range of conditions, checked in the simulator every two years by two assessors, as well as being formally interviewed. In the oil companies, a range of performance monitoring methods are used to evaluate the competence of the OIM, including appraisals from peers and managers. One of an OIM's safety-critical roles is to take charge in an offshore emergency and this is assessed by observing performance in simulated exercises offshore and in some cases in an onshore simulator. Frequency of formal assessment ranges from one to three years. In all three cases, the assessment process plays a dual role, not only of licence/ authorisation revalidation, but also of providing feedback to enhance individual performance.

The literature on **skill decay** for given professions is surprisingly limited, so the periodicity of re-assessment varies across sectors, and also across roles within a given industry. Formal checks ranged from six months to every three years, although the three industries surveyed emphasised the importance of ongoing, informal monitoring of performance, especially for staff in safety-critical positions. Attention is given to how **competence is maintained between assessments**, in many cases this will simply be through daily task repetition but special attention is paid to tasks conducted very infrequently that are of high criticality/ consequence. Ongoing hazard and risk assessments (e.g. from accident and incident analyses) enable competence assurance systems to be tailored to changing task risks and requirements.

iii. Clearly defined standards of competence

Competence is usually defined as the ability to perform the activities within an occupation to the standards expected in employment. The competence assessment procedures in all three cases were based on detailed **standards of competence** derived from task analyses. In the aviation industry, these are derived from international requirements; in the energy sector, companies may use industry standards or develop their own competency frameworks. The **methods of competence assessment** for appointment and revalidation include a licensed examiner or qualified assessor observing and evaluating job performance during normal operations or in a simulator (where unusual events can be staged). The proficiency measures are **outcome based,** observed performance scores, appraisal records, interview ratings - rather than examining input data (such as experience or training). There is a range of methods that can be used to collect job performance data for competence assessment, see Wright et al (2003) or Fletcher (2000) for examples.

iv. Trained and accredited assessors

One of the notable features of the aviation proficiency check regime is not only the systems in place for regular training and assessment of licence holders but also the assurance procedures used to check the **competence of the authorised examiners**. It is well recognised that an effective assessment programme needs to pay particular attention to the **reliability and validity** of the evaluation procedure in order to be fair and defensible, and to achieve general acceptance from the profession concerned. This means that the assessors need to be trained and to be 'calibrated' against the desired standards, to ensure maximum inter-rater reliability in their judgements. In the aviation industry, a system is in place where the examiners themselves undergo regular assessments to ensure that their evaluations are competent and aligned to national standards.

v. Non-technical skills

The aviation and nuclear power companies (and their regulators) are particularly concerned with the training and assessment of **non-technical (cognitive and social) skills** inherent in safe job performance. These are skills such as situation awareness, decision making, leadership, team work and understanding of personal limitations (e.g. the effects of stress and fatigue) - deficits in these skills are known to contribute to adverse events in both industry and health care (Flin & Maran, 2004). Current regulations in aviation require that these skills are formally checked, along with pilots' technical skills. Behavioural rating systems have been produced for this purpose. A fuller description of non-technical skills and their current application in acute medicine is provided in Appendix 2.

vi. Failure of competence assessment

Where an individual **fails** a competence check, the organisations have clear procedures in place for reassessment and/or retraining. In the very unusual case of a repeated fail, the individual would not be returned to the role.

vii Simulators

In the three industries sampled, **simulators** are used as part of the competence assessment process. For flight decks and nuclear plants, these are normally full-fidelity technical simulators that are approved by the regulator for assessment purposes. There are a range of simulated patients used in medical education and assessment, however at present, these are more advanced in some specialities (e.g. anaesthesia, see Rall & Gaba, 2005) than others.

viii. Health checks

In all three organisations, there are systems in place to ensure physical and mental fitness for duty: They have regular **medical checks** and in the case of pilots, these are conducted by regulator-approved medical examiners. In addition, all the companies have policies in place for **drug and alcohol testing** procedures.

ix. Linkage of competence assessment to safety management

For the oil and nuclear power sectors, the regulator (HSE) adopts a goal setting, safety case regime. The companies are required to run their operations using safety systems that will maintain the risks at a level 'as low as reasonably practical' (ALARP principle), however they can decide on their own methods of safety management including the procedures relating to competence assurance for staff in safety-critical positions. Their competence assessment processes are integrated into their overall competence assurance systems (selection, training, employee support), as well as their **safety management systems.** The level and frequency of competence assessment may be linked to **operational risk assessments**. In this way competence requirements can be regularly updated to meet changing task requirements and risk profiles. Feedback from the competence assessments may reveal new training needs or organisational risk exposure. Some airlines have developed special software packages for tracking assessment data in order to continuously review and improve their professional training programmes.

Companies in all three sectors have a raft of other **safety management techniques** in place, some of which (e.g. flight data tracking, safety climate surveys and confidential reporting systems), can provide general alerting mechanisms for performance weaknesses within a given operating unit. In essence these are cross-monitoring systems. The resulting data can provide an additional source of competence monitoring to complement individual competence assurance checks.

5. 3 Costs

There are considerable costs involved both for the regulator and the operating companies in a full licensing and revalidation programme overseen by the regulator, as in the aviation industry. The annual budget of the Safety Regulation Group of the CAA (which includes licensing) is approximately £70 million. It is difficult to accurately estimate the costs to air operators but these are significant. Their most senior pilots have to be taken off operational duties to undergo training and assessment to become approved TRIs and TREs, as well as to conduct the regular assessment sessions. A company may have 8-10% of its captains qualified and licensed as TREs. (If the CAA has to provide an examiner, then the company will be charged approximately £1300 for each licence check). The air operators also have senior captains employed full time to manage the Standards (Licensing) departments in their companies. In addition, there are the costs involved in taking the pilots off flying duties to undergo their regular competence assessments in the simulator. There can be other costs, for instance when a Line Training Captain flies on a normal line flight on a small aircraft to assess the pilot, the payload of passengers may have to be reduced to accommodate this.

In the nuclear industry, the main costs of authorisation and revalidation are to the operating companies, as the UK regulator issues site licences rather than licences to individual staff. The oil industry is in a similar position. The companies appear to regard these costs as part of their normal safety management budget to ensure competence assurance for staff holding safety critical positions or undertaking safety critical operations.

6. Conclusion

The systems used for licensing and competence assurance in three high risk industries were examined. While these sectors are different from healthcare in a number of respects, there do appear to be some general principles that might be adapted for licensing and revalidation in health care professions.

i. Independent regulator

ii. Regular formal proficiency checks.

iii. Clearly defined standards of competence.

iv. Trained and accredited assessors.

v. Focus on non-technical skills.

vi. Procedures for dealing with failure.

vii. Use of simulators.

viii. Regular health checks.

ix. Linkage of competence assessment to safety management systems.

The data from a well-designed and carefully managed competence assessment system can provide valuable information not only for the individual concerned but also for professional training programmes and organisational risk management.

References

ASCSNI (1990) *Study Group on Human Factors: First Report on Training and Related Matters.* HSE: Advisory Committee on the Safety of Nuclear Installations.

Catchpole, K., Giddings, A., de Leval, M., Gallivan, S., Godden, P, Utley, M., Dale, T. & Hirst, G. (2005) Identifying and reducing systems failures through non-technical skills. In *Proceedings of the Royal College of Surgeons Edinburgh Quincentennial Conference, Edinburgh, July. Surgeon, Supplement FP1.4*

Catto, G. (2005) Building on the GMC's achievements. *British Medical Journal, 330,* 1205-1207.

Cullen, D. (1990) *The Public Inquiry into the Piper Alpha Disaster. Vols. 1 & 2 (Cm1310).* London: HMSO.

Dauphinee, W. (2005) Self regulation must be made to work. *British Medical Journal, 330,* 1385-1387.

Department of Health (2001) *Building a Safer NHS for Patients.* London: author.

Donaldson, L. (1994) Doctors with problems in an NHS workforce. *British Medical Journal, 308,* 1277-1282.

CAA (2003) *Crew Resource Management (CRM) Training. CAP 737.* London: Civil Aviation Authority.

Fletcher, G., Flin, R., Maran, N., Glavin, R. & Patey, R (2003) Anaesthetists' non-technical skills (ANTS): Evaluation of a behavioural marker system. *British Journal of Anaesthesia, 90,* 580-588.

Fletcher, S. (2000) *Competence-based Assessment Techniques.* London: Kogan Page.

Flin, R., Martin, L., Goeters, K. et al (2003) Development of the NOTECHS (non-technical skills) system for assessing pilots' CRM skills. *Human Factors and Aerospace Safety, 3,* 95-117.

Flin, R. & Maran, N. (2004) Identifying and training non-technical skills in acute medicine. *Quality and Safety in Health Care, 13 (Suppl I),* i80-i84.

Flin, R. & Yule, S. (2004) Leadership and safety: lessons from industry. *Quality and Safety in Health Care, 13 (Suppl II),* ii45 - ii51.

Flin, R. & Yule, S. (2005) Advances in patient safety: Non-technical skills in surgery. *Surgeons News: Royal College of Surgeons of Edinburgh, 4,* 83-85.

Helmreich, R. (2002) Crew performance monitoring programme continues to grow and evolve as database grows. *ICAO Journal,* 57, 6-7.

IAEA (1996) *Nuclear Power Plant Personnel Training and its Evaluation. A Guidebook. Technical Report 380.* Vienna: IAEA.

Misumi, J., Wilpert, B. & Miller, R. (1999) (Eds.) *Nuclear Safety: A Human Factors Perspective.* London: Taylor and Francis.

NII (2004) *Assessment of Licensees' Arrangements for Training and Competence Assessment.* T/AST/027 Issue 1 October. Bootle: HSE, Nuclear Installations Inspectorate.

RAeS (1998) *Guide to Performance Standards for Instructors of Crew Resource Management (CRM) Training in Commercial Aviation.* London: Royal Aeronautical Society/ Civil Aviation Authority, Air Training Association.

Rall, M. & Gaba, D. (2005) Patient simulators. In R. Miller (Ed.) *Miller's Anesthesia. (6 ed.)* Philadelphia: Oxford.

Rosenthal, M. (1995) *The Incompetent Doctor. Behind Closed Doors.* Buckingham: Open University Press.

Slaven, G. (1995). Competence frameworks in safety critical industries. *Executive Development*, *8,* 21-22.

Smith, J. (2004) *Safeguarding Patients: Lessons from the Past - Proposals for the Future. Shipman Inquiry: Fifth Report*. London: HMSO.

Timmermans, S. & Berg, M. (2003) *The Gold Standard. The Challenge of Evidence-Based Medicine and Standardization in Health Care.* Philadelphia: Temple University Press.

UKOOA (2004) *Industry Guidelines for the Management of Competence and Training in Emergency Response for Offshore Installations.* London: United Kingdom Offshore Operators Association.

Vincent, C., Neale, G. & Woloshynowych, M. (2001) Adverse events in British hospitals. Preliminary retrospective review. *British Medical Journal, 322,* 517-519.

Wright, M., Turner, D. & Horbury, C. (2003) *Competence Assessment for the Hazardous Industries. Research Report 086.* London: HSE Books.

Yee, B., et al (2005) Nontechnical skills in anesthesia crisis management with repeated exposure to simulation-based education. *Anesthesiology, 103,* 241-248.

Yule, S., Flin, R., Paterson-Brown, S. & Maran, N. (in press) Surgeons' non-technical skills : A review of the literature. *Surgery.*

Websites

CAA www.caa.co.uk

HSE www.hse.gov.uk

ICAO www.icao.int

Shipman Inquiry www.the-shipman-inquiry.org.uk

Appendix 1. Interview Schedule

1. Identification of safety critical role/s to be discussed. Size of target population in UK.

2. Relevant regulatory authority (UK/ EU): legislation, regulations, guidance.

3. Issue of licences or other authorisation.

   a) Origins of legislation. Specific trigger event?

   b) Content of legislation, role of the regulator, degree of devolved responsibility to operating company.

   c) Process for issue of licences/ authorisations. Documentation.

   d) Period of licence validity.

   e) Revalidation process. Consequences of failing revalidation assessment.

   f) Training and qualification of Licence Examiners/ Assessors.

4. Technical *vs.* Non-Technical Skills

5. Medical Fitness

   a) Examination procedure/ frequency/ consequences of fail

   b) Drug and Alcohol testing

   c) Retirement

6. Operation of licensing/ revalidation system

   a) Current satisfaction with system.

   b) Costs.

   c) Future developments.

7. Other Safety Management/ HR Systems that monitor performance

Appendix 2. Non-Technical Skills

The term non-technical skills (NTS) was first introduced by the European civil aviation regulator, the Joint Aviation Authorities (JAA). They can be defined as, 'the cognitive and social skills of flight crew members in the cockpit, not directly related to aircraft control, system management, and standard operating procedures'
(Flin et al 2003, p96).

Over twenty years ago, a series of major aviation accidents, without primary technical cause, forced investigators to turn their attention to the behaviours of the pilots who had been operating the aircraft. For example, in 1977, two Boeing 747 planes operated by KLM and Pan Am crashed on the runway at Los Rodeos, Tenerife; United Airlines had also suffered a sequence of crashes late 1970s without primary technical failures. The aviation psychologists and airline training captains began to scrutinise the behaviours associated with these accidents, reporting their findings at a NASA conference in 1979. The emerging culprits were failures in leadership, poor team co-ordination, communication breakdowns, lack of assertiveness, loss of attention, inadequate decision making, and personal limitations, usually relating to stress and fatigue.

Accidents involving inadequacies in non-technical skills are not unique to the aviation industry. In nuclear power plant incidents, operator errors relating to loss of situation awareness, flawed decision making have played a major role. In the military domain, the accidental attack by the *USS Vincennes* on a passenger aircraft killing all the passengers and crew was caused by weaknesses in tactical decision making, communication failures and lack of team co-ordination. The loss of the *Piper Alpha* oil platform with 167 deaths was caused by poor communication at shift handover, compounded by leadership failures in emergency response. Shipping accidents are frequently characterised by failures in bridge team leadership issues, problems in crew co-operation or individual risk judgements. In hospital medicine, rates of adverse events to patients in London were found to be about 10% of admissions (Vincent et al, 2001) – in acute medicine many of these are attributed to failures in decision making, leadership and breakdowns in teamwork (Yule et al, in press).

Once the aviation industry realised that the maintenance of high standards of safety was going to require more than efficient technology and proficient technical skills in the system operators (e.g. pilots, air traffic controllers), it began the necessary programmes of research to identify the key non-technical skills. These were not mysterious or rare behaviour patterns, they were the normal skills that pilots regarded as an essential part of good airmanship. However these NTS had often been tacitly rather than explicitly addressed and consequently taught in an informal and inconsistent manner from one generation of pilots to the next. Studies were commissioned by the airlines and the Federal Aviation Authority (FAA) at the leading aviation psychology centres, such as the Crew Factors Group at NASA Ames and the Human Factors Aerospace Group at University of Texas, Austin. Working with experienced pilots, the aviation psychologists began to run experiments in the flight deck simulators, to interview pilots, to analyse accident reports, to discover which skill components either contributed to accidents or were effective in preventing adverse events. Once the core NTS had been identified, then the airlines began to develop special training courses to raise awareness of the importance of these skills, to provide the necessary underpinning knowledge and practice for skill development.
These were initially called Cockpit Resource Management (CRM) courses, later amended to Crew Resource Management as other team members such as cabin crew began to be involved. In the last decade, many other industries have started to introduce CRM training, such as nuclear power generation, Merchant Navy, prison service, hospital medicine. By the 1990s some airlines and several of the regulators were interested in whether the CRM (non-technical) skills being trained were transferring to the workplace. Some of the larger airlines had already developed what they called behavioural marker systems for this purpose, usually linked to assessment and coaching. These systems were based on taxonomies of key non-technical skills, and provided exemplar good and poor behaviours as indicators of component skills, along with a rating form for assessment.

In 2001, the European Joint Aviation Authorities (JAA) addressed the training and assessment of Crew Resource Management (CRM) skills as set out in the CRM regulations included in JAR OPS (2001) 1.940, 1.945, 1.955, and 1.965, asking for an evaluation of flight crews' CRM skills. For example, '*the flight crew must be assessed on their CRM skills in accordance with a methodology acceptable to the Authority* *and published in the Operations Manual. The purpose of such an assessment is to: provide feedback to the crew collectively and individually and serve to identify retraining; and be used to improve the CRM training system.'* (1.965).

This legislation resulted from a desire by the JAA from the mid 1990s, to achieve a generic method of evaluation of non-technical skills throughout the JAA countries and JAA operators. Such a generic method would minimize cultural and corporate differences, and maximize practicability and effectiveness for airline instructors and examiners. As a consequence, in 1996, the JAA Project Advisory Group on Human Factors initiated a project group that was sponsored by four European Civil Aviation Authorities (Germany, France, Netherlands, UK). A research consortium consisting of members from DLR (Germany), IMASSA (France), NLR (Netherlands) and University of Aberdeen (UK) was established to work on what was called the NOTECHS (Non-Technical Skills) project. The group was required to identify or to develop a feasible and efficient methodology for assessing pilots' non-technical (CRM) skills. The design requirements were (i) that the system was to be used to assess the skills of an individual pilot, rather than a crew, and (ii) it was to be suitable for use across Europe, by both large and small operators, i.e. it was to be culturally-robust.

As a result, the NOTECHS system was designed as a prototype for use by European airlines (Flin et al, 2003) and the UK regulator cites NOTECHS as a possible method for making the required assessment of pilots' non-technical skills (CAA, 2003). There are now European requirements for non-technical skills assessment in both the flight crew licensing requirements (JAR-FCL 1.240; 1.295) and operational requirements (JAR-OPS 1.965; 1.005(a) App.1): although the requirements are congruent, they are not entirely harmonised.

Similar systems have been developed for us in anaesthesia (ANTS (Anaesthetists' Non-Technical Skills) (Fletcher, Flin et al, 2003; Rall & Gaba, 2005; Yee et al 2005). New research has been undertaken to develop a system for surgeons (NOTSS - Non-Technical Skills for Surgeons) (Flin & Yule, 2005; Yule, Flin, Paterson-Brown & Maran, in press), with other research teams now also studying errors and non-technical skills in surgery using an adaptation of the aviation NOTECHS system (Catchpole et al, 2005).

Appendix 3. Extract from UK Nuclear Site Licence (2005)

12 Duly Authorised and Other Suitably Qualified and Experienced Persons

1. The licensee shall make and implement adequate arrangements to ensure that only suitably qualified and experienced persons perform any duties which may affect the safety of operations on the site or any duties assigned by or under these conditions or any arrangements required under these conditions.

2. The aforesaid arrangements shall also provide for the appointment, in appropriate cases, of duly authorised person to control and supervise operations which may affect plant safety.

3. The licensee shall submit to the Executive for approval such part or parts of the aforesaid arrangements as the Executive may specify.

4. The licensee shall ensure that once approved no alteration or amendment is made to the approved arrangements unless the Executive has approved such alteration or amendment.

5. The licensee shall ensure that no person continues to act as duly authorised person if, in the opinion of the Executive, he is unfit to act in that capacity and the Executive has notified the licensee to that effect.

26 Control and Supervision of Operations

The licensee shall ensure that no operations are carried out which may affect safety except under the control and supervision of suitably qualified and experienced persons appointed for that purpose by the licensee.