Personnel Licensing Developments: New Clues for Investigators.

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This paper outlines international developments in ICAO Annex 1 with the establishment of an expert panel for the investigation of competency measures for entry control. It describes initiatives currently underway in both Australia and New Zealand for the measurement of practical flight crew competencies and the knowledge deficiency reports associated with theoretical competency examinations. It will provide example linkages between these competencies and accident investigation outcomes that suggest a review of competency attainment at licensing level might well provide investigators with clues for further examination. More importantly, it may provide a vehicle for data driven recommendations that might prove to be a tangible safety benefit to the travelling public.

Civil aviation safety regulatory authorities play an important role in the provision of safe transport. How the authority exercises power varies from State to State depending on the relationship it has with other government entities and the industry, which it regulates. Progressive developments in quality management and quality systems encourage governments to place more control and therefore responsibility in the private and semi government sectors. More and more responsibility is being given to the operators across the board, matched by a move towards audit and compliance. Those audit and compliance records in various forms provide significant opportunity for 'data mining'. This paper considers one of those opportunities.

In September 2000, an ICAO informal meeting on Annex 1 licensing standards took place in Madrid, Spain. The outcome of that meeting was a request to the Air Navigation Commission to consider reviewing those standards. At their January meeting this year, the Air Navigation Commission considered that request and put the proposal to their member States. In part their letter of intent read as follows:

"Twenty years have elapsed since the last revision of the Annex 1 flight crew specifications was initiated. Since then, major developments in respect of aircraft operations and training have taken place. The changes in aircraft operations are well known. Operators are now using sophisticated aircraft, operated by two-person flight crews, and in an environment of increasing complexity. At the same time, general aviation continues to use aircraft of a technology that largely derives from the 1950s. Licensing standards must therefore be able to cater for the widening spread between the different sectors of aircraft operation and the different aircraft and equipment being used.

Over these last twenty years, considerable changes have also taken place in relation to aviation training. In a number of ICAO States, reliance is increasingly being placed on large ab initio training schools as the supply of pilots from general aviation and the military fails to keep up with current demand. In addition, the fact that the training tools available today, e.g. flight simulators and computer-based training, have the potential of offering better and faster training, means that the licensing credits given on the basis of these tools need to be carefully re-examined. Finally the need for more effective training has led several States to develop competency training and licensing requirements that incorporate more explicit criteria for measuring competence."

The Commission proposed the following objectives of the task:

- "Review the flight crew licensing and training Standards of Annex 1 and the flight crew training Standards of Annex 6, Part I, para 9.3 and Part III, Section II, para 7.3, in order to ensure their continued relevance in meeting current and anticipated future needs while preserving and improving upon existing flight safety levels;
- Determine whether competency based flight crew training Standards could complement and/or replace existing Standards based upon the formulation of knowledge, skill and experience;
- Review the structure of licences and ratings to ensure that they provide an effective and efficient path toward the future aviation career goals of the applicant; and,
- Develop the guidance material required to support the new Standards, while keeping in mind the fundamental need to preserve and to protect commonly accepted civil air transport flight crew personnel seniority practices and agreements."

The last bullet point is a significant retraction from the *tabula rasa* approach requested at the informal meeting.

That process is now underway. States and International Organisations which have membership to that panel are: Australia, Brazil, Canada, Chile, Egypt, France, Germany, Japan, Mexico, Netherlands, Russian Federation, Singapore, South Africa, United Kingdom, United States, International Council of Aircraft Owner and Pilot Associations (IAOPA), International Air Transport Association (IATA), International Business Aviation Council (IBAC), International Federation of Air Line Pilots Associations (IFALPA). It should be noted that neither New Zealand nor ISASI are represented.

The panel's brief is now as follows:

1) Development of provisions on the approval of training organizations including the quality system, which is required to ensure that the objectives of the training system is maintained.

2) Review the flight crew licensing and training Standards of Annex 1 and the flight crew training Standards of Annex 6, Part I, paragraph 9.3, and Part III, Section II, paragraph 7.3, in order to ensure their continued relevance in meeting current and anticipated needs while preserving and improving upon existing flight safety levels.

3) Review the structure of licences and ratings to ensure that they provide an efficient path toward the future activities of the applicant:

   a) determine the core competences required by the professional pilot;

   b) determine the competency required for single-pilot and multi-crew operations; and

   c) determine the optimum point at which to commence multi-crew training.

4) Determine whether competency based flight crew Standards could complement and/or replace existing Standards based upon the knowledge, skill and experience.

5) Assess the use of synthetic devices in acquiring or maintaining the competences required for the various levels of licences and ratings, taking into account the type of device being used, and determine the credit to be given for the use of such devices.

6) Develop the guidance material required to support the new Standards.

Australia and New Zealand have already made some headway in developing competency-based measures for flight crew licensing though they have evolved along quite different pathways. In Australia's case, national competency standards did not exist in the aviation industry until recently though flight-training organizations were training pilots to the CASA syllabus. The new National competency standards were a joint effort between industry and the regulatory authority and were endorsed by the industry prior to ratification by CASA.

CASA and the Australian National Training Authority along Australian Qualifications Framework Guidelines have now published the Aeroplane Competency Standards. The following extract from CPL Day VFR Syllabus in that document gives a broad indication of the structure of their competency measures:

Unit 23 is just by way of example.

UNIT: 23. CONTROL AEROPLANE SOLELY BY REFERENCE TO FULL INSTRUMENT PANEL (CPL)

Field: Commercial Pilot Fixed Wing

Description:

Skills and knowledge to perform all normal flight using the full instrument panel to reestablish VFR conditions.

Elements	Performance Criteria
23.1 Perform manoeuvres	• Maintain straight and level flight, climb, descend, perform rate one turn, recover from unusual attitudes and resume controlled flight solely by reference to full instrument panel.

KEY COMPETENCIES

Collect, analyse & organise information	Communicate ideas & information	Plan & organise activities	Work with others and in teams	Use mathematical ideas & techniques	Solve problems	Use technology
2	1	2	1	2	2	2

RANGE OF VARIABLES

Variable	Scope
1. Workplace environment may include	Aeroplane with or without mechanical or electric starter, fixed or variable pitch propeller, brakes, flaps, slats or retractable undercarriage, or Approved flight simulator and synthetic flight trainer in accordance with CAR requirements. Classes of airspace as designated by the regulator.
2. Sources of information may include	Flight Manual/POH, CAR/CASR, CAO, AIP, ERS(A), Charts, Operations Manual, Approved checklist.
3. Regulations/ legislation may include but are not limited to	CAR/CASR, CAO,AIP.
4. Consistency of performance	*When manipulating flight controls during the process of correcting errors, specified flight tolerances may temporarily be exceeded if controlled corrective action is in progress as those tolerances are exceeded.* *Actions are consistently performed in accordance with relevant legislative requirements, Flight Manual/POH, operations manual, approved checklist or ATC directions and within the following specifications and tolerances:* *Straight and level flight ±50 RPM ± 0.5" MAP, 150 ft, ±10°, ±10 kts nominated air speed.* *Climb ±50 RPM ± 0.5" MAP, ±10°, ±5 kts nominated climb speed.* *Descend ±50 RPM ± 0.5" MAP, ±10°, ±5 kts nominated descent speed, ±150ft/min nominated rate of descent.* *Rate one turn ±50 RPM ± 0.5" MAP, ± 150 ft, ±10 kts nominated air speed , ±10° nominated heading.*

EVIDENCE GUIDE

1. Critical aspects of evidence	Assessment must confirm the ability to: use instrument scan techniques applicable to the condition of flight; compensate for the secondary effects of controls; maintain orientation under instrument flight conditions; and control the aeroplane by reference to the artificial horizon and gyro compass.
2. Interdependent assessment of units	This unit of competency may be assessed in conjunction with other units that form part of a job role or function. Competence in all elements of all units relevant to a particular qualification must be demonstrated.
3. Underpinning knowledge and skills	A knowledge of, or the ability to apply knowledge of (determined by questioning or observation of performance or application): the function and limitations of flight instruments; pitot, airframe and carburettor icing and prevention/removal procedures; instrument failure warning flags and indications; the physiological factors which may affect pilots instrument flight; the attitude and power requirements for respective conditions of flight; and instrument scan technique.
4. Context of assessment	Assessment should verify that control of the aeroplane or situation is maintained at all times and in such a manner that the successful outcome of a procedure or manoeuvre is not in doubt. Flight instruments must include artificial horizon and gyro heading indicator. This competency should be performed normally under simulated instrument flight conditions where actual conditions cannot be used. Approved synthetic flight trainers may be used in accordance with CAR requirements. Assessment should include determination of underpinning knowledge and skills with regard to the application of the required aeronautical knowledge and applicable legislation.

ASSESSMENT GUIDE

During assessment the pilot should be observed to perform the following checks and actions as evidence of ability to meet the licensing standards.

The checks and actions detailed in this guide are advisory. Checks and actions in approved checklists, placards, Flight Manual/POHs, or Operations Manuals have precedence and must be complied with.

Elements	Evidence
23.1 Perform manoeuvres	*Before instrument flight:* Pitot/static systems are checked for serviceability and condition. Flight instruments are checked for condition and serviceability. Instrument power sources are checked. The attitude indicator pitch datum is set to the inflight straight and level attitude appropriate for the aircraft type. Turn, heading and attitude indicators are functionally checked while taxiing. *During instrument flight:* Attitude indicator is used as primary control instrument for pitch and roll. Performance instruments are used with selective radial scan to confirm attitude. Other instruments and indicators are interrogated and reacted to appropriately. Applicable scan technique for straight and level stage of flight is used. Lag in performance instruments is anticipated and allowed for. Aeroplane is balanced. Timely instrument interrogation rate is practiced. Engine instruments are monitored and reacted to. Power and attitude are used to achieve performance (±50 RPM ±0.5" MAP). Straight and level flight is achieved at changing airspeed (± 10 knots ± 10°, ±150 ft). Straight and level flight is achieved in different flight configurations. The change-check-hold-adjust-trim technique of instrument flying is utilised. *Additional evidence while climbing and descending during instrument flight:* Climb is achieved at nominated speed (± 5 knots). Descent is performed at 500 feet per minute (±150 ft/min) at a nominated speed (± 10 kts). Level off altitudes-are anticipated. *Additional evidence while performing turns during instrument flight:* Applicable selective radial scan technique for turns during level, climbing and descending stages of flight is used. Rate one turns onto specific headings are completed (±10° ±150 ft). Turning and acceleration errors are compensated for when using magnetic compass. *Additional evidence while simulating establishment of VFR after unintentional entry into cloud:* Straight and level flight is maintained on full instrument panel. Present heading is observed and reciprocal heading calculated. Rate one turn onto reciprocal heading is performed. When on reciprocal heading, wings are maintained level and time is allowed to exit cloud. VFR is established. *Additional evidence while recovering from unusual attitudes:* Low or decreasing airspeed attitudes are compensated for by application of power and lowering of nose to horizon. High or increasing airspeed is corrected by reducing power, levelling wings parallel to horizon and raising nose to horizon. Attitude indicator is used as primary control instrument. Bank angle is corrected by paralleling wings to horizon using attitude indicator. Straight and level attitude is achieved without excessive oscillations at the horizon (± 200 ft of height at which aircraft nose first passed through horizon). Performance instruments are used to confirm attitudes. Elements of Airmanship: Adverse physiological sensations are accepted but ignored. Corrective control movements are smooth and excessive muscular force avoided. Instrument power sources are checked for serviceability and monitored in flight. Heading instruments are synchronised before take-off and every 10 minutes in flight.

These measures are currently in use in Australia for entry control flight tests.

In terms of the theoretical components of personnel licensing in Australia, CASA has moved to a computer-based internet delivery system through ASL and they can now keep track of every question that an individual candidate has attempted and their result for each and every question of each and every exam. This has provided the capability to provide feedback to candidates in the form of Knowledge Deficiency Reports (KDRs). These reports outline the subject area/s that candidates had trouble with during the exam both for future reference and for further study.

ASL has been using KDRs in New Zealand for a number of years now and they have been well received by industry and the regulator. Though the exams are still paper based here at present, a record of every result for every question of every examination is recorded on their central database. The capability to monitor trends through data mining within this database is spectacular. ASL monitors the performance of each question, of each paper of each of the sections as well as individual candidates, specific training organisations and national trends. The following is an example KDR provided to training organisations:

Knowledge Deficiency Report - Training Organisations

ACME FLYING SCHOOL From Date 1/10/00 To Date 31/10/00

Subject Title CPL Flight Navigation General

Topic Description	% Passed
Aeronautical Charts	78.57%
Flight Planning	85.71%
Flight Plans	89.80%
General	77.78%
PNR and ETP	71.43%
Time	100.00%

Summary for CPL Flight Navigation General

Acme Flying School (6 Topics)	79.95%

Subject Title CPL General Aircraft Technical Knowledge (A)

Topic Description	% Passed
Airframes	62.62%
Direct Reading Compass	82.14%
Electricity and Magnetism	86.52%
Engines	77.17%
General	90.91%
Handling of Piston Engine Aircraft	80.00%
Instruments	58.70%
Weight and Balance	73.38%

Summary for CPL General Aircraft Technical Knowledge (A)

Acme Flying School (8 Topics)	73.65%

In terms of flight-testing competencies, New Zealand has taken a somewhat different tack to Australia. Through some initial research done at Massey University, the CAA has been developing word pictures that describe the behaviours associated with attaining different levels of competency rather than just concentrating on the entry control standard itself. The rationale behind this approach is that there is no guarantee that we currently have the minimum standards correct even if we were all able to measure to that standard. In principle, accident and incident statistics citing specific causal or contributory factors should be able to tell us whether we need to raise certain standards, to reduce accident and incident rates or indeed whether we should be able to lower other standards to reduce entry control costs to individuals. The NZ format is as follows:

Task: Instrument flight - straight and level

Objective:

To determine that the candidate is capable of;

(a) Achieving and maintaining straight and level flight at a nominated altitude ± 100 feet using full panel instruments.

(b) Maintaining the (DI) heading ± 5 degrees and checking, at appropriate intervals, the DI against the magnetic compass.

(c) Trimming the aircraft accurately to maintain straight and level flight.

Action:

The examiner will;

(a) Nominate the altitude at which level flight will be entered and maintained.

(b) Nominate the heading to be maintained and observe that the DI is correctly aligned.

(c) Place emphasis on the candidate's demonstration of accurate altitude, heading and balance control using full panel instruments.

(d) Ensure the aircraft is trimmed accurately for level flight.

(e) Make allowance for fluctuations due to turbulence (but not excessively so).

Instrument Flight - Straight and Level

Rating

0_____7_____10

(1) Is unable to anticipate the level off using full panel instruments	*(1) Anticipates the level off using full panel instruments*	*(1) Accurately anticipates the level off using full panel instruments*
(2) Maintains an altitude in excess of 100 feet of the nominated altitude using full panel instruments	*(2) Maintains the nominated altitude within 100 feet using full panel instruments*	*(2) Maintains the nominated altitude accurately using full panel instruments*
(3) Consistently deviates from the nominated heading by more than 5 degrees or fails to ensure the DI is aligned with the compass	*(3) Maintains the nominated heading within ± 5 degrees using full panel instruments and occasionally compares the DI with compass heading*	*(3) Maintains the nominated heading accurately using full panel instruments, realigning the DI as required*
(4) Makes no attempt to trim the aircraft	*(4) Trims for the straight and level attitude*	*(4) Trims accurately for the straight and level attitude*

FAIL **PASS**

This information has not been published widely yet and is still in the early trial stages with ASL Flight Testing Officers. John Parker from the Personnel Licensing Unit of the CAA is happy to distribute them on request. The intention is to get the observations to a point where there are a number of competency attainment levels for each of the required tasks. A database of achievement for flight test candidates would then provide the industry, instructors and the regulator with data driven target areas for education and standards setting.

The implications for investigators are twofold. First, the databases will eventually contain a wealth of information about the progress of individuals through their time in the civil aviation system. Instrument flight competency attainment for example can be tracked over time. For instance, the farmer who did well with his or her instrument aspects during the licensing flight test but whose attainment levels have trended down over subsequent Biennial Flight Reviews due lack of match practice might well be a candidate for disorientation if inadvertently caught in cloud. In principle, there will be sufficient data for investigators to infer specific competence at any time for any individual and that should, through the power of the modern computer, extend to the competency of that person's co-pilot, his or her instructor/s and testing officers for all of the time they have been active in the civil aviation system, and eventually the air traffic controller on watch at the time.

Second, and perhaps more importantly, it should provide a measure of system performance and it is this area that investigators can provide the most significant benefit to our civil aviation system. Investigators will be in a position to recommend training and competency standards across the system and even identify specific tasks, which might need to be measured for entry control

and/or on-going activity in the civil aviation system. In particular, investigators will be able to compare the specific attainment levels of individuals not only with their NZ colleagues but also with the standards of the other foremost aviation nations whose performance records are far superior to ours. We might then be able to put our finger on what really makes this country a more hazardous place to fly in. The current conjecture on the reason such as hazardous terrain, bad weather, antiquated initial training; inappropriate testing or the other myriad of reasons seeking to justify our accident rates can be either substantiated or refuted through data comparison. Then our investigators may be in apposition to justify recommendations that will return a positive safety benefit to the people of New Zealand.

In summary, the current training and testing methodologies for entry into the civil aviation system are not meeting the needs of industry. This has been recognised by ICAO and a Flight Crew Licensing Panel has been set in place to review Annex I. This will be followed by review of the other licences disciplines required by the Annex. Australia and New Zealand are leading the research and development into competency-based measures though CASA and CAANZ have taken somewhat different approaches to date. A combined effort that is likely to result from the Trans Tasman Mutual Recognition Agreement should result in a comprehensive database providing information on the competency status of all active individuals in the civil aviation system. Co-operation has already commenced with the ASL taking on the theory examination delivery of CASA examinations. The database will provide significant information to aid accident and incident investigators in determining causal and contributory factors for accidents and incidents. Perhaps most importantly, the database will contain benchmarks of industry competency and recommendations to alter those benchmarks through education or regulation should provide for a tangible safety and/or cost benefit to the nation.