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Aviation Licensing and Lifetime Management – What Can Nuclear Learn?

A Report by the World Nuclear Association's Working Group on Cooperation in Reactor Design Evaluation and Licensing (CORDEL Group)

World Nuclear Association

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The World Nuclear Association's Working Group on Cooperation in Reactor Design Evaluation and Licensing (CORDEL) promotes standardization of nuclear reactor designs on the merit of improved economics and safety offered through building reactors in series and capitalizing on the broad basis for experience exchange.

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Executive Summary

This report, written by the Design Change Management Task Force of the World Nuclear Association's (WNA's) Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group, explores design licensing and design change management procedures in the civil aviation industry.

Both the nuclear and aviation industries operate within global and highly regulated regimes, and share an overall goal of excellence in safety and reliability. In the civil aviation industry, safety has been greatly enhanced in the last decades, as indicated by a significant decrease in the fatal accident rate.[1] A major contributor to this has been international standardization and harmonization of the design approval and change management procedures. It is therefore likely that a review of the regulatory processes of the aviation industry will be of benefit to the nuclear industry.

Licensing of aircraft designs is based on a set of binding international minimum standards defined in Annex 8 of the 1944 Chicago Convention, supplemented by national airworthiness regulations. A type certificate is issued by the state of origin for the aircraft design. Type certificates are also issued separately by each state where that particular design of aircraft is registered. In addition, each aircraft is issued with an airworthiness certificate in the state in which the aircraft is registered.

Throughout the life of an aircraft design, the original designer is always involved in the response to events and safety-relevant findings. For serious events, the aviation authority of the state of design may issue an airworthiness directive, which will be based on solutions proposed by the original designer. This airworthiness directive requires other national authorities to implement remedial measures to their regulated entities, making sure that changes are applied consistently over the entire fleet of aircraft of the same design.

Several lessons can be learned from this industry's system of regulation, including:

- Achievement of a UN-backed political agreement on the acceptance of basic safety requirements (Chicago Convention Annex 8).
- The design licensing (type certificate) process and bi- and multilateral acceptance agreements.
- Design change management and maintenance of type certificate throughout the lifetime of an aircraft design.
- Execution of the design authority role by manufacturers.
- Maintenance of the responsibility of national regulators within an internationally agreed framework.

[1] The fatal accident rate (the global rate of accidents involving passenger fatalities in scheduled operations per 10 million flights) decreased significantly in the last 20 years, from 21 (in 1993) to an average of 5 over the last few years. See Figure 2-1, *Annual Safety Review 2011*, European Aviation Safety Agency (EASA), www.easa.europa.eu/communications/docs/annual-safety-review/2011/EASA-Annual-Safety-Review-2011.pdf

1 Introduction

This report was written by the Design Change Management (DCM) Task Force of WNA's Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group. The DCM Task Force explores ways to share and analyze existing practice, to seek best practice, and to consider recommendations to be made to all stakeholders for the benefit of improved safety and the lifetime standardization of reactor designs. CORDEL has been investigating the regulatory system of the aviation industry for several years, and some basic findings were outlined in its 2010 Roadmap.[2] Due to its excellent record of enhancing safety and reducing the likelihood of accidents, the aviation industry may serve as a case study for the nuclear industry.

The focus of this report is on aviation safety (or 'airworthiness') and how it is ensured by all stakeholders within a defined regulatory system. The factors that have shaped this system are compared with those of the nuclear industry. The intention, however, is not to propose revolutionary changes to nuclear regulation by, for example, the creation of an international regulatory safety agency. In aviation, as in nuclear, national regulators are competent authorities of sovereign states and discharge the full range of duties of a regulator. The pertinent aspect of aviation, for the purposes of this report, is the well-balanced system of safety cooperation between regulators, operators, designers and suppliers both on the national and international levels.

CAN AVIATION BE A MODEL FOR NUCLEAR?

The nuclear and aviation industries have much in common. Both industries operate within global and highly regulated regimes, and share an overall goal of excellence in safety and reliability. The international regulatory framework in aviation is strongly influenced by the fact that aircraft frequently cross national borders. And nuclear safety also has a natural cross-border effect, as radiological and political/social consequences of an accident might spread to other countries.

Two aspects of the regulatory system in aviation deserve special attention:

- A strong international framework for safety that does not interfere with or undermine the authority of individual states and their national regulatory organizations.
- A system of aircraft design management comprising exchange of operating experience, a common response to findings and events and a systematic approach to design changes, creating clear interfaces of responsibilities and allocation of risks and liabilities among designers, manufacturers and operators.

The 'passports' for an aircraft to be able to fly across borders are its certificate of registration and its airworthiness certificate, both of which do not have a parallel in nuclear. (The same goes for the licensing of airports and the regulation of air traffic control systems.) Of more relevance to nuclear is the 'type certificate', which is awarded to the designer of an aircraft and confirms that the design complies with the applicable safety requirements. This type certificate evolves over the lifetime of the design and its development is tightly framed by an effective regulatory system. It has much in common with a design

[2] WNA CORDEL, International Standardization of Nuclear Reactor Designs, 2010. The report is available at http://www.world-nuclear.org/uploadedFiles/org/reference/pdf/CORDELreport2010.pdf

certificate or the design part of a construction licence in nuclear, and it offers many lessons in how to establish strong international management of design improvements.

It is sometimes assumed that, in contrast to the system of nuclear regulation, there is a centralized system of international regulation for the aviation industry to which national regulators surrender the greater part of their sovereignty. This is a misperception: national aviation regulators have the same degree of authority and responsibility as their peers in nuclear. The worldwide framework for aviation regulation, governed by the 1944 Convention on International Civil Aviation (the Chicago Convention) and the International Civil Aviation Organization (ICAO), does not involve transfer of responsibilities; it only sets a framework for each regulator to fully discharge its duties.

2 The Pillars of Aviation Regulation

In aviation, each country has its own regulations (airworthiness codes) and its own regulatory authority (national aviation authority). On the international level, the regulatory framework for safety in aviation is constituted by the 1944 Chicago Convention[3], which has universal adherence[4]. The Convention created the International Civil Aviation Organization (ICAO).

The ICAO is empowered to adopt and amend standards and recommended practices (SARPs). The ICAO SARPs on aircraft design safety establish minimum standards[5] and are collected in Annex 8 to the Convention. They are binding on member states (see figure 1).

The foreword to Annex 8 states:

> *It was recognized that the ICAO standards of airworthiness would not replace national regulations and that national codes of airworthiness containing the full scope and extent of detail considered necessary by individual states would be necessary as the basis for the certification of individual aircraft. Each state would establish its own comprehensive and detailed code of airworthiness.*

Therefore, each state has its own national airworthiness codes, which provide a means to comply with high-level safety objectives and indicate how the regulator intends to verify that a product is airworthy. Even if this is done on a national basis, the differences are not significant. It is essentially possible for aircraft designers to design their aircraft to an 'envelope' encompassing a number of relevant national or regional standards (for example, US, Canada and EU).

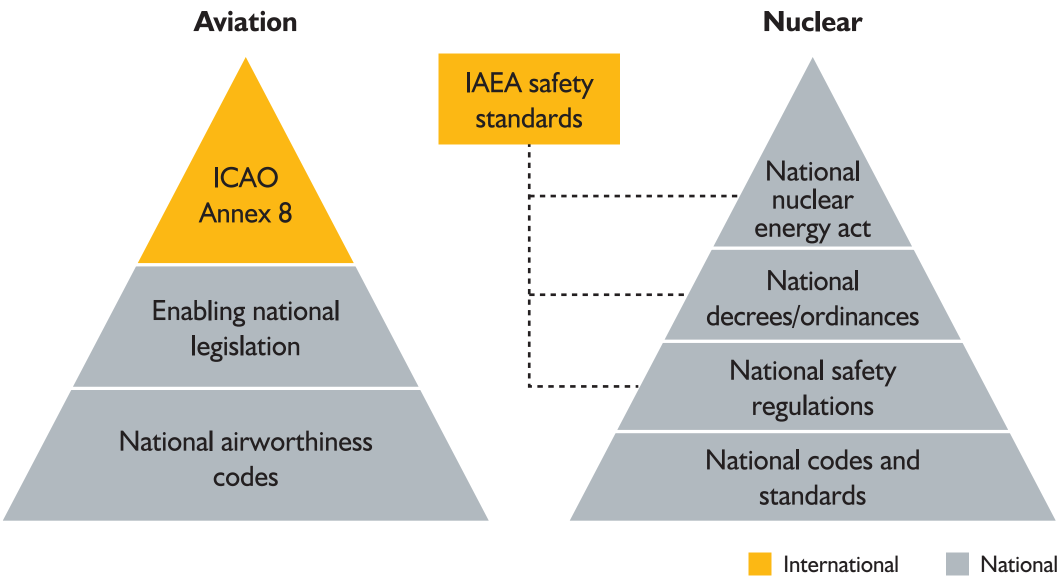

Figure 1: Hierarchy of the safety regulation system ('regulatory pyramid') in aviation and in nuclear

[3] 1944 Chicago Convention; see http://www.icao.int/publications/pages/doc7300.aspx
[4] http://www.icao.int/secretariat/legal/List%20of%20Parties/Chicago_EN.pdf
[5] See Article 33 of the Convention

It is also worth noting that the ICAO has a mandatory auditing tool, the ICAO Universal Safety Oversight Audit Programme (USOAP). The USOAP audits focus on the state's capability for providing safety oversight by assessing whether the critical elements of a safety oversight system have been implemented effectively. This includes determining the state's level of implementation of safety-relevant ICAO SARPs. ICAO member states are required to host an audit at least once every six years.

In nuclear, there is also a full regulatory system in each country plus an overarching international framework shaped by conventions and institutions.

There is no single convention with the broad scope of the Chicago Convention. In the area of nuclear safety, the Convention on Nuclear Safety follows an incentive concept without a real enforcement mechanism. Besides, it does not establish any safety requirements, but rather obliges states to implement regulatory systems which take due account of safety issues.

As an institution, the International Atomic Energy Agency (IAEA) has a role broadly similar to the ICAO and also creates standards and recommendations at a high level of detail. However, contrary to Annex 8 standards, the IAEA standards are not binding on member states (see figure 1). This might be because, historically, the aim of the ICAO seems to have been a reduction in accidents and fatalities, while the main objective of the IAEA was to promote the peaceful uses of atomic energy without furthering any military purpose. While the establishment of safety standards is a function of the IAEA, the agency does not have the same level of authority in nuclear safety as it has in the area of nuclear safeguarding, where it is the world's 'nuclear watchdog'. In practice, the most important IAEA standards, for example those on plant design[6], are generally accepted as minimum standards. In order to assess implementation of IAEA standards, the IAEA offers voluntary peer reviews to assess the implementation of its standards, and these are being taken up by an increasing number of states. Legally, however, this is not comparable to the mandatory ICAO USOAP.

There are also voluntary initiatives by other international institutions, such as the Nuclear Energy Agency of the OECD, that foster safety mainly via working groups and their reports, and international regulators' groups such as the Western European Nuclear Regulators' Association (WENRA) and the Multinational Design Evaluation Programme (MDEP), which cooperate to develop safety initiatives and guidelines. Again, the main difference to the ICAO is the voluntary character of collaboration.

As to national nuclear safety standards, in spite of the lack of mandatory minimum standards, there is a tendency towards alignment due to the increased importance of IAEA standards and regional guidelines (such as WENRA reference levels). However, there are still some significant differences between countries regarding national legal/regulatory requirements and national industry codes and standards.

[6] *Safety of Nuclear Power Plants: Design*, International Atomic Energy Agency SSR-2/1 (2012)

3 Licensing of Aircraft

Annex 8 contains a section on "procedures for certification and continuing airworthiness" where the notions of type certificate, airworthiness certificate and continuing airworthiness are defined and made mandatory.

For each aircraft design, the designer must first obtain a type certificate from the state of design (the country in which the designer is established). In some countries, the design organization itself must be approved (this is known in Europe as 'design organization approval', DOA).

It is important to stress that this initial type certificate is not valid in other states. If an aircraft of this design is to be registered in another state, the designer needs to apply for a separate type certificate issued by the authority of the state of registry (see figure 2). (This type certificate is also the basis for the airworthiness certificate subsequently issued to the aircraft owner.) In practice, many countries are not able to conduct the investigations necessary to issue the type certificate and just accept the one delivered by the state of design.

A national airworthiness authority issues its type certificate if the design complies with its own national airworthiness codes. As mentioned earlier, national airworthiness codes do have differences, but large designers design their planes to an envelope of relevant national requirements.

In addition, each individual aircraft needs an airworthiness certificate (or certificate of airworthiness) from the competent authority of its state of registry, attesting that it is fully compliant with the approved design.

In nuclear there is no equivalent to the aviation system of defining certain licences. While there is a universally agreed scope of safety evaluation for a nuclear plant, which must cover all relevant stages of its life (siting-design-construction-commissioning-operation-decommissioning)[7], each state is free to define the scope of licences. For example, some states have one licence covering several stages of a plant's lifecycle, while others have a multi-step licensing system with separate licences for construction and for operation. Similarly, some states have introduced a standalone design approval procedure, whereas others might deal with the design within the scope of the construction licence. Thus, there is a great variety of licensing formats which makes any international comparison, let alone acceptance, very difficult.

In those countries that do have a generic nuclear design approval process, this can be compared to the type certificate.

[7] Licensing Process for Nuclear Installations, chapter 3.1, International Atomic Energy Agency SSG-12 (2010)

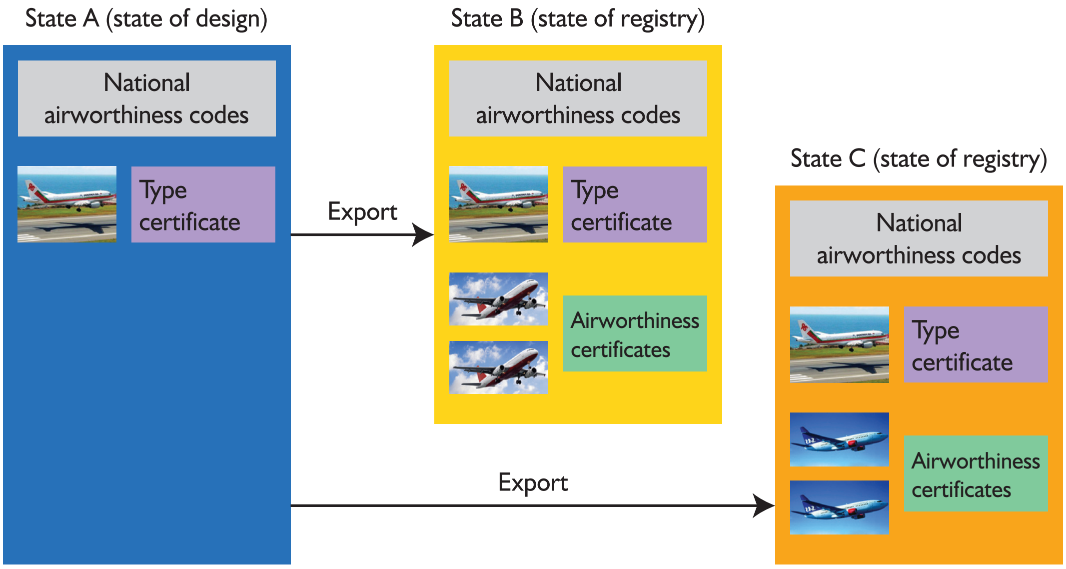

Figure 2: International system of type certificates and airworthiness certificates

There has been steady progress towards standardization and shared certification, which has been largely driven by the manufacturers' wish to avoid having to obtain multiple certificates for the same type of aircraft. In many cases, the manufacturers had to make changes to their designs to accommodate the views of national experts.

The regulators have also benefitted from a more standardized approach. For example, it was becoming more difficult to certify increasingly complex products with a limited number of regulatory staff. Additionally, regulators (including the large ones) came to realize the safety benefits to be reaped from a standardized approach, given the larger basis for experience feedback and the more structured implementation of design improvements. Another advantage of standardization relates to judicial proceedings following aircraft accidents. Experience showed that regulators were in a stronger position during such proceedings if they could demonstrate that they had worked in cooperation with other regulators and that their decisions were not taken unilaterally.

The designers of large commercial aircraft will apply for type certificates in several countries simultaneously. During its design review, the aviation authority of the state of design would involve experts from the aviation authorities of those countries. This sometimes results in almost simultaneous production of type certificates in several countries. Authorities which do their review later will also closely cooperate with the authority of the state of design. In such cases the authority of a state of registry can ask the state of design's authority to check compliance with its own airworthiness regulations. In practice, the application for a type certificate in a state of registry can be filed via the authority of the state of design – the designer may ask it to engage with the other authority. It is important to stress, however, that each of these regulators takes an independent decision. (Some countries are not able to conduct their own full review of the design of imported aircraft and may legislate to automatically accept the type certification of the state of design.)

International cooperation is also achieved through the conclusion of bilateral airworthiness agreements (or bilateral aviation safety agreements, BASAs). These are intergovernmental agreements through which national authorities accept the design review work done by the regulator of the state of design and only assess compliance with their own requirements where they differ from those of the state of design ('additional conditions' or 'national delta'). Prior to concluding a bilateral airworthiness agreement, the states involved conduct a review of each other's authorities and procedures in order to ensure that the work of the other regulator can be accepted. Even when such an agreement has been concluded, authorities may still choose to do a full review themselves. In any case, they remain accountable to their national governments.

Bilateral airworthiness agreements have been concluded for several decades between major design countries, such as the US, Canada, France, UK and Germany.

In nuclear, there is no cross-border validity of reactor design approvals, as is the case for type certificates. Regarding the collaboration of national regulators, though not as extensive, the framework of the Multinational Design Evaluation Programme (MDEP) has much in common with the system of cooperation between aviation regulators.

There is no counterpart in nuclear to bilateral airworthiness agreements. The concept of accepting the licence given by another regulator after evaluation of the 'national delta' has not been carried out in the nuclear field.

4 Post-licensing Aspects: Continued Airworthiness, Design Changes and Repairs

Once the type certificate has been issued, there are two aspects affecting the design which can be treated separately. One is the question of design changes needed to address safety deficiencies (in other words, to ensure "continued airworthiness"). The other is the issue of changing the design for other reasons, for example in order to improve the performance or to repair an aircraft.

CONTINUED AIRWORTHINESS

When an aircraft type is certified, a number of safety assumptions are made that may be later disproved or affected by operational experience. An aircraft designer might therefore only be issued a type certificate on the condition that it continuously carries out safety assessments of its fleet. In addition, all other parties have a legal obligation to report occurrences that may have an impact on the design.

Each party has a clearly defined role in reporting and responding to findings and events:

Aircraft operators are responsible for operating the aircraft in accordance with the flight manual, which is part of the type certificate. They are also responsible for ensuring that the aircraft remains compliant with the approved design. This means that maintenance work is performed as specified in the type certificate, that airworthiness directives (see below) are implemented and that changes and repairs are done in accordance with an approved design. Operators must report safety-relevant findings to their national aviation authorities.

Maintenance organizations perform the work specified in the type certificate and should report any problem they encounter to both their national authority and the original designer. The same applies to manufacturers.

Designers should collect and analyze all information related to failures, malfunctions and defects of their products. They should make information of this collection and analysis system available to all known operators and, provided the information is safety-relevant, they should also notify the authority of their state (state of design). In case they consider, or their regulator considers, that there is a safety issue, they should provide the risk analysis and technical solutions upon which the airworthiness directive is written.

Regulators take action by issuing airworthiness directives, which require operators to take specific action to address safety issues. The airworthiness directive defines a safety threat, the required action to be taken by operators, and the maximum reaction time.

Any regulator of a state of registry that has identified a safety threat should transmit all relevant information both to the state of design and to the designer. The regulator of the state of design will take action, for example by issuing an airworthiness directive, and inform all states of registry of the aircraft concerned. The state of registry may first issue an airworthiness directive (which would be valid for its own territory) but in practice the authorities concerned would wait for the state of design's authority to issue its directive first.

Annex 8 requires all states to take action if the state of design publishes mandatory continuing airworthiness information such as an airworthiness directive. Every regulator should "upon receipt of mandatory continuing airworthiness information from the state of design, adopt the mandatory information directly or assess the information received and take appropriate action"[8]. Thus, the airworthiness directive is the basis for other national authorities to implement remedial measures to their regulated entities, making sure that design improvements are spread consistently over the entire fleet of aircraft of the same design.

When production of an aircraft type has ceased, the designer usually keeps the type certificate valid by following current regulations, collaborating with authorities on issuing airworthiness directives and service bulletins, as well as providing spares and technical support to the owners and operators of this aircraft type, provided there is still a business case.

In case a designer exits the market, a solution has to be found since the airworthiness certificates of the affected design would be invalidated if the duties associated with the type certificate are not discharged. In these cases, the parties involved would normally arrange for a new entity to take over the type certificate. This new entity will often be the design management and manufacturing/maintenance part of the designer (sometimes under a different name or as a new company). In other cases, the state itself may take over the type certificate. For old or historic designs where only a limited number of aircraft is still in service, the operator can assume design responsibility under certain conditions ("permit to fly").

[8] Airworthiness of Aircraft, Annex 8 to the Convention on International Civil Aviation, Eleventh Edition (July 2010), II-4.2.3d, International Civil Aviation Organization.

In nuclear, the role of the designer is entirely different to the aviation industry. The nuclear vendor/designer does not have the ongoing design responsibility that the aviation designer acquires when it receives the type certificate.

The prime responsibility for design and safety (i.e. "design authority", see INSAG-19[9]) lies with the operator/licensee of a nuclear power plant[10]. It makes decisions regarding design changes and must have sufficient knowledge to evaluate the consequences of any proposed change.

As a result of this difference to the system of aviation licensing, the nuclear industry has no comparable reporting and reaction system centred on the designer and the state of design, nor any mechanism that is comparable to an airworthiness directive. There are some similarities in event reporting and operational excellence exchange systems (e.g. via the International Atomic Energy Agency, World Association of Nuclear Operators, or EU Clearinghouse), but the reaction to findings is much less organized. The owners' groups, comprising the reactor designer and the utilities owning a reactor of this design, do play a role in disseminating information on events and findings and in proposing design changes. However, this is not very systematic and not mandatory. Every individual operator is expected to maintain its own database for its individual plant, and include in it information from other industry sources as it thinks fit.

In addition, nuclear regulators do not have a comparable system of mutual exchange of data nor is there a mandatory system for cooperation on safety directives. Finally, when regulators issue orders to licensees to implement design changes, this is not done on the basis of the designer's risk analysis and technical proposals (though there may be consultation with the licensee beforehand).

All this may partly be due to a lesser degree of standardization in reactor designs. Conversely, if more standardization were to be achieved, this may make it possible to implement highly efficient systems analogous to those of the aviation industry.

DESIGN CHANGES AND REPAIRS

Aircraft and engines designed by one entity are delivered to many customers in many different countries. There is, however, no legally centralized system through which changes to the design of these products can be made, e.g. with a requirement that only the original designer may make changes. This results in a rather complex system.

The vast majority of significant changes are made by the original designer and approved by the state of registry. Bilateral agreements usually provide for mutual assistance with the state of design in such cases. When there is no such agreement, many states rely on an approval issued by the state of design.

When a different entity from the original designer wishes to make a significant change, it should apply for a supplemental type certificate from the state of registry of the aircraft. Here again, international cooperation may facilitate the issuing of such certificates. In most cases, the competent authority will seek the opinion of the original designer as much as possible.

[9] Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life, INSAG-19, International Atomic Energy Agency (2003), available at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1178_web.pdf
[10] See Art. 9 of the Convention on Nuclear Safety and Principle 1 of the IAEA Fundamental Safety Principles (Safety Fundamentals).

The designer must demonstrate that, once the change has been implemented ("embodied"), the product in question would meet the original safety standard (or the local equivalent). Although there is no international system of certification or authorization of entities to perform design changes, in practice the vast majority of substantial changes are done by the holder of the original type certificate or with its technical support.

Original designers continuously work on their designs and frequently introduce design changes which lead to increased performance or reduced maintenance cost and time. Instructions for the embodiment of such changes to operators and maintenance bases are published in service bulletins.

A notion in aviation which is less familiar to the 'nuclear reader' is "repair". This is defined as elimination of damage and/or restoration to an airworthy condition when a part is found to exceed serviceable limits (as defined by the designer), and is understood to involve a design modification. (Elimination of damage by replacement of parts or appliances without need of design activity is a maintenance activity and not a repair.) Major "repair design" has to be approved much like design changes, i.e. involving the competent authority of the state of registry (and the state of design if the repair is conceived by an entity that is not the original designer). Here again most countries accept the design changes and repairs approved by the original state of design, or else bilateral agreements provide for cooperation between the states of registry and the state of design to facilitate the approval of such changes and repairs.

Though somewhat complicated, this system guarantees that aircraft designs develop under regulatory control so that safety is not compromised. There is a strong case for involvement of the original designer but other qualified organizations may design changes or repairs as well.

Design changes are controlled differently in the nuclear industry to the aviation industry for the same reasons as the handling of safety issues. The prime responsibility for safety lies with the operator/licensee of a nuclear power plant. The operator may or may not request the original designer to design and implement the changes, either making changes itself or contracting another designer or engineering company. In practice, this leads to nuclear power plants of the same design but owned by different entities to develop in diverging directions.

Currently, a nuclear plant designer does not have a defined responsibility. In those regulatory systems which feature a design certification procedure, the designer can be considered to be the "owner" of this document[11] and it can apply for a revision.[12] For any nuclear plant that has been built, however, the principle of prime responsibility of the operator applies. Any design changes are submitted by the operator to the regulator according to nationally defined procedures (licence modification, approval of the regulator based on licence conditions, notification to the regulator, etc.). The designer is not part of this administrative procedure. While there is no international system of design change management, some elements of voluntary coordination have been introduced by the owners groups uniting the vendor with the operators of nuclear units of the same design.

[11] It is understood that US design certification is issued as a Nuclear Regulatory Commission rule and therefore legally speaking has no "owner".

[12] See as an example the AP1000 certification in the USA. The first design certificate for the Westinghouse AP1000 was issued in 2006. In 2008, Westinghouse applied for an amended design certificate based on a modified AP1000 design. The NRC issued the amended design certificate in late 2011.

5 The European Approach

Europe is an example of a remarkable regional development. In recent decades, national regulators have tended to increase cooperation, culminating in the creation of the European Aviation Safety Agency (EASA) in 2002, which has taken over some of the regulatory tasks of the national agencies.

In 1970, the main European national regulators founded the Joint Aviation Authorities (JAA). The two main objectives of this association were:

- To facilitate certification of aircraft designed jointly in Europe (for example, the Concorde).
- To achieve a greater alignment of European national standards with each other and with the US standards.

The JAA was a voluntary association of national regulators. From 1970 onwards, considerable alignment of national standards along common requirements – referred to as the Joint Aviation Requirements (JARs) – was reached.

EASA can be compared to the Western European Nuclear Regulators' Association (WENRA). In the framework of WENRA, European nuclear regulators created common reference levels for nuclear safety and committed themselves to implement them in their national regulations. As in the early phase of JAA, this initial alignment of safety standards is not linked to mandatory cooperation in licensing.

In 1990, the national regulatory authority members of EASA signed the "Cyprus Arrangements"[13]. The parties agreed to:

- Develop common rules and certification procedures and to incorporate them in their national legislation.
- Jointly certify the products designed in their countries or imported from other countries.
- Conduct regular inspections to verify that the common rules and procedures are effectively and uniformly implemented by all parties.

Concerning the first point, the authorities agreed "to work to remove as rapidly as possible any national variants or national regulatory differences with the aim that each individual existing JAR becomes a uniform code for all JAA countries and no further national regulatory differences are applied."

There was a practical mechanism for reaching this aim without jeopardising the authorities' obligations and duties founded on their national legislation: "Each authority intends to withdraw the provision for codes other than JAR…when that authority estimates that the procedures are such that they allow fulfilment of its national obligations as civil aviation authority and achievement of the associated deadlines using only JARs."

[13] Arrangements Concerning the Development, the Acceptance and the Implementation of Joint Aviation Requirements, Cyprus, 11 September 1990, https://easa.europa.eu/rulemaking/docs/international/archive/cyprus.pdf

Concerning the second point (joint assessment and approval of aircraft designs), the authorities agreed "to make only once all the technical findings in those fields while each national Authority would still make the legal findings."[14]

Founded on this principle, the authorities would "establish administrative and technical procedures which would require a single administrative action from the applicant for each application and which would replace the currently existing national administrative documents by a single one valid under the national laws and procedures of each authority."

It was considered important that each party had an adequate level of knowledge and understanding, as effective collaboration could not simply be imposed by political decision, but had to evolve in a framework of growing mutual trust.

As a result, certificates issued collectively by the parties, in accordance with common rules and procedures, were accepted automatically without additional conditions for the issuing of any party's national certificate.

In the light of the creation of EASA, which took over a certain number of tasks alongside the national authorities, JAA had fulfilled its historical task and was disbanded in 2009.

In nuclear, this degree of collaboration between regulators has not yet been reached in the European Union or anywhere else. However, there is no reason why the Cyprus Arrangements could not be a blueprint for an agreement between nuclear regulators. They ensure enhanced cooperation, gradual alignment of standards and acceptance of joint licencing procedures while at the same time safeguarding the sovereignty of national regulators and legislation.

[14] "Technical findings" refers to the assessment of whether a design complies with the relevant requirements, while "legal findings" refers to granting a certificate as required by national laws and procedures. Essentially, the aim was to carry out design evaluation only once while each national authority would still issue its own licence.

6 Current Initiatives and Developments

Aviation has a strong safety record. However, given the constant increase in air traffic, the main challenge is to keep the number of accidents and victims at the absolute level of today. This means further reducing the likelihood of accidents.

In close cooperation with the ICAO, the aviation industry has created a "Global Aviation Safety Roadmap"[15]. Its objective is "to provide a common frame of reference for all stakeholders ..., thus reducing the accident risk for commercial aviation". The roadmap focuses on improvements for implementation of international standards, for regulatory oversight, for reporting and analyzing errors and incidents, for consistent compliance with regulatory requirements and for adoption of industry best practice.

In July 2007, the ICAO adopted the Global Aviation Safety Plan (GASP)[16]. This embodies the ICAO strategy for states, regions and industry to address the focus areas identified in the roadmap.

One major issue of the roadmap and of GASP is to cope with the difference in accident rates per region. Therefore, the roadmap encourages regional initiatives and institutions and recommends focused action, taking into account that for some regions it is important to first correct infrastructure and other deficiencies before moving onto more sophisticated safety initiatives.

A current development in aviation is the strengthening of safety management systems (SMSs). This is an area where nuclear industry and nuclear regulation is possibly more advanced, as it seems that aviation still relies more on a compliance-based approach. The ICAO is currently developing a new annex to the Convention (Annex 19) assembling all SMS requirements. ICAO plans to adopt Annex 19 in November 2013.

In nuclear, the Fukushima accident has led to a renewed focus on nuclear safety and to a surge of international initiatives. The IAEA Action Plan on Nuclear Safety[17] proposes some initiatives, but consists mainly of recommendations to strengthen the implementation of existing instruments. The issue of strengthening nuclear safety requires bolder decisions which should go in the direction of stronger international cooperation of all stakeholders in a system of balanced and clearly attributed responsibilities and with some mandatory elements. Again, the regulatory system in aviation could serve as a template.

[15] The Roadmap consists of two parts: Part 1 – Global Aviation Safety Roadmap; Part 2 – Implementing the Global Aviation Safety Roadmap. The documents can be found at http://legacy.icao.int/fsix/library1.cfm

[16] http://www.icao.int/safety/GASP%20Doc/GASP_en.pdf

[17] http://www.iaea.org/newscenter/focus/actionplan/

7 Conclusions

Civil aviation has a mature system for:

- The assignment of responsibility between states.
- The assessment of competency in organizations.
- The creation of safety standards.
- The evaluation of products and changes to products.

This system is based on a global framework, national standards, and the oversight of both products and organizations by national aviation authorities. This is complemented by strong international cooperation of regulators and the voluntary cross-acceptance of certification by regulators through the conclusion of bilateral airworthiness agreements.

This system could be used as a model for the ideas developed by the DCM Task Force of WNA's CORDEL Working Group and explained in the July 2012 report *Design Change Management in Regulation of Nuclear Fleets*[18]. The main ideas are the following:

- Generally, CORDEL is promoting international standardization of reactor designs which can be built alike in different countries. This would allow for many of the elements of the aviation system to be adopted.
- The benefits of standardization must be given their full weight in all design change decisions. The vendor/designer should at least have an advisory role to ensure that important design improvements are implemented in all reactors of the same design around the globe.
- As the responsibility of the original designer/vendor for the oversight of its entire international fleet increases, the design authority concept should imply sharing of responsibilities between the utility and the vendor.
- Progress towards design standardization can be achieved through owners groups. Membership of all the utilities operating the 'same' design should be strongly encouraged if not mandated by their regulator.
- Reactor vendors should publish service bulletins, analogous to their aviation peers, on both safety and operational matters. The significant safety issues should result in recommendations to be adopted by owners groups' members and made mandatory by the national regulatory bodies for safety significant recommendations.

The aviation industry has created a system of international cooperation, mutual acceptance and highly effective mechanisms of sharing design information, as well as reacting jointly and uniformly to findings and occurrences. At the same time each national authority retaions its sovereignty and its competence.

At such a crucial time for the nuclear industry, it is essential that safety continues to be enhanced. This could be achieved by adopting a system of close international cooperation similar to that developed and used by the aviation industry.

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