THE AUSTRALIAN SPACE ACTIVITIES REGULATORY FRAMEWORK: ENSURING RISK-BASED SAFETY ASSESSMENTS, ADAPTABLE FOR A GROWING SPACE ECOSYSTEM.

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ABSTRACT

Australia first enacted civil space legislation in the *Space Activities Act 1998*, largely as a response to various space launch proposals in the 1990s. The current S*pace (Launches and Returns) Act 2018* (the Act) and the associated framework modernised Australian civil space legislation, focusing on civil space-related activities carried out either from or to Australia, or by Australians overseas.

This paper will discuss the challenges and the opportunities in establishing and further developing the space launch and returns regime in Australia, review changes that have occurred since the initial establishment, discuss lessons learned from the initial applications under the updated legislation, and review potential initiatives for improvement in the future.

The Act and associated framework included revised minimum safety risk criteria for third parties and assets, aligning with international criteria. Importantly, given the nascent market in Australia for space launches and returns, the Act also established a flexible framework that allows applications to be commensurate with the complexity and risk of the proposed activity.

This flexible approach was established before the updated US FAA Part 450 regulations were released and has been effectively used by both new and established domestic and international organisations, though not without some challenges.

A benefit of the Australian legislation is that it caters to a wide variety of space activities, risk profiles and complexities. From the JAXA *Hayabusa2* capsule return to South Australia and the first launches from a commercial launch facility of NASA sounding rockets outside of the USA in the Northern Territory of Australia, to the launch of suborbital rockets by start-up companies at commercial spaceports, to the launch of multiple Australian satellites from launch sites outside Australia, the legislation and process has proven effective at handling the various complexities and risks associated with space activities.

The legislation also permits recognition of work done by other international regulatory bodies, either by enabling an expedited review process focused on the verification of previously completed work against unique Australian regulatory requirements, or in some cases, through a formal Technical Registration Instrument. Applicants may choose to use internationally approved methodologies or submit their own approach to meet the legislative requirements, including safety.

As has been seen in other jurisdictions, one challenge with a flexible approach is that it can be hard, especially for new applicants, to understand where to begin and what constitutes a sufficiently complete application. In addition, further developing a new regulatory body to support space launch and returns has also required the growth and upskilling of both the assessors and the applicants. To help address these challenges, additional planning and coordination have and are being introduced early in the application process, and additional guidance materials and tools are being developed.

This paper will discuss how Australian space regulation has established a flexible framework that has been effectively implemented for varying maturities and complexities of space launch and returns activities. In the future, the development of additional guidance and tools will further enhance usability and speed of regulator processes for space activities for Australia.

1. HISTORICAL CONTEXT

When the UN General Assembly established the Committee on the Peaceful Uses of Outer Space in 1959, Australia was one of its founding members. By 1967 Australia was one of only a handful of space-faring nations with the launch of the WRESAT satellite from

the Woomera Rocket Range in South Australia, the second-busiest launch range in the Western World at that time behind the Kennedy Space Centre at Cape Canaveral in Florida [1].

Yet, from the 1980s up to about 2020, spaceflight activities in Australia were almost non-existent except for various suborbital launches testing combustion technology. Multiple commercial and government space ventures failed, mostly before any launch activity. The return of the Japan Aerospace Exploration Agency (JAXA) *Hayabusa* spacecraft from an asteroid to Woomera in 2010, followed by *Hayabusa2* in 2020, being notable exceptions.

Consequently, the Australian space activities regulatory framework of the era under the *Space Activities Act 1998* was rarely exercised and was essentially static.

2. BENEFITS OF AUSTRALIA FOR SPACE

Australia offers unique benefits for space activities. One of these benefits is that Australia's "geography facilitates [the] ability to reach the vital equatorial low-earth orbit … as well as geostationary and Sun-synchronous and polar orbits from Australian launch sites" [2].

Another benefit is the size of the country, and the large areas with very low populations, which can make meeting mandatory risk criteria for launches and returns easier than in other places in the world.

Figure 1. Overlay of map of Australia map (rotated) onto Europe [3]

This can be clearly seen in **Figure 1** and **Figure 2** which shows the Australia superimposed on Europe and the United States respectively. For comparison, the areas of each are Europe at 10 million sq km [4], contiguous United States at 8 million sq km [5], and Australia at 7.7 million sq km [6].

Figure 2. Overlay of map of Australia map (rotated) onto United States of America [3]

The total population distribution in **Figure 3** shows how vast areas of Australia are sparsely populated with light yellow indicating a population of less than 500 per square kilometre (sq-km), light orange up to 2000 per sq-km, and red indicating 5000-8000 people per sq km.

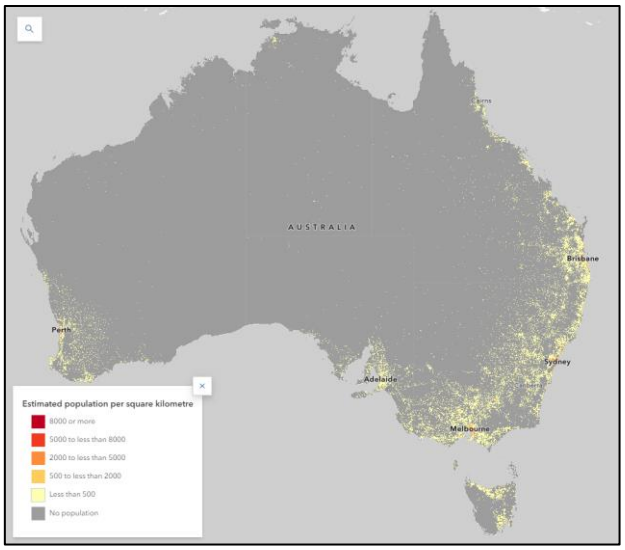

Figure 3. Estimated population density 2022-23 from the Australian Bureau of Statistics (ABS) regional population grid interactive map [7]

When the area and population density are coupled with the proximity to large oceans and relatively low-density maritime shipping and air traffic routes in areas around the continent, it is clear why Australia is a great choice for launch and return activities.

3. UPDATING TO CURRENT LEGISLATION

The Australian Government first introduced a legislative framework to regulate commercial space activities in 1998. It created regulations governing licencing, insurance object registration, range safety, fees and liability requirements.

In the later 2010s, Australia began to see a clear uptick in investment in space activities, both related to satellite technologies as well as to the development of launch capabilities in country. This paralleled global markets as new space and small rocket launches became an investment focus world-wide.

The Australian Government established the Australian Space Agency (ASA), "on 1 July 2018 to coordinate civil space matters across government and support the growth and transformation of Australia's space industry" [9]. The ASA's mission is "to work across government, industry and academia to advance Australia's position in the global space economy" [9].

In parallel, Australia also recognised the need for updated legislation covering emerging variants for space launches and returns to enable the nascent industry while protecting the safety of the public. Major amendments were passed by Australian Parliament in 2018, including renaming the civil space legislation to the *Space (Launches and Returns) Act 2018* (the Act). The new Act defines the framework and requirements for space launch or return activities in Australia or by Australians.

The supporting *Space (Launches and Returns) (General) Rules 2019*, *Space (Launches and Returns) (High Power Rocket Rules) 2019*, and *Space (Launches and Returns) (Insurance) Rules 2019* (hereafter referred to as 'the Rules') were published in 2019. The Rules support the operation of the Act by providing additional detail and requirements. The Rules also incorporate supporting material in the form of the Flight Safety Code and Maximum Probable Loss Methodology. The Flight Safety Code defines third party risk criteria and flight safety system standards for certain civil launch and return activities in Australia, while the Maximum Probable Loss methodology sets out the method to calculate the maximum probable loss that might occur due to certain space activities.

The Australian regulations were developed from the outset with a focus on commercial activities, with the intent to embed the flexibility to accommodate a wide range of current and emerging space activities, in addition to addressing existing Australian environmental, occupational safety, and other regulatory requirements. With commercial applications in mind, the intent was also to minimise regulatory hurdles and complexity in the application process, in part by giving applicants the flexibility to demonstrate their ability to meet the safety standards via their preferred analytical approach rather than being required to conform to a prescribed format.

As mentioned, the Act established the criteria for space launch and return activities. Broadly, these include:

- Activities must be conducted in a way to reduce the probability of substantial harm to third-party people and property to as low as reasonably practicable
- Activities are conducted by competent persons
- All required environmental approvals are received or plans developed
- Proper insurance / financial coverage is in place
- The activities should not occur is there are concerns relevant to the security, defence or international relations of Australia
- That the criteria in the Rules are addressed.

The Rules (and supporting documents) then establish more detailed requirements to demonstrate that the broad criteria of the Act are met. For example, depending on the application, the General Rules require details on the personnel who will be performing key roles, which supports demonstrating the Act criteria related to competence. Similarly, the General Rules require design and specification information about the space object and the provision of safety plans, both of which are criteria to support the Act's criteria that the probability for harm to third parties is as low as reasonably practicable.

Furthermore, the Flight Safety Code defines a quantitative approach for determining the probability of risk for launches and returns and specifies the required minimum safety standards. In Australia, there is a maximum collective risk requirement that must be met for each launch or return, as well as a maximum individual risk requirement on a per launch or return, and a per year basis. These safety criteria align with international criteria as shown in **Table 1**.

Table 1. Comparison of launch safety criteria from different regulatory bodies globally (per mission) [10]

Regulatory Body	Collective Risk	Individual Risk
Australia	1×10^{-4}	1×10^{-6}
US (FAA)	1×10^{-4}	1×10^{-6}
France	2×10^{-5}	--
UK	1×10^{-4}	1×10^{-6} #
# Per year, not per mission basis		

The Act and Rules do not currently address or have any provisions for crewed space flight.

4. FLEXIBLITY & ADAPTABILITY

The US Federal Aviation Administration (FAA) published on 30 September 2020 the Streamlined Launch and Reentry Licensing Requirements (SLR2) Rule, which "streamlines and increases flexibility in the FAA's commercial space launch and reentry regulations" [12]. SLR2 was then released into the Code of Federal Regulations (CFR) under Part 450 Launch and Reentry License Requirements. The Australian regulations, updated the year prior to SLR2, include a similar approach.

As mentioned above, the Australian space regulations were developed as a framework for commercial activities. The regulations are designed to be flexible – able to accommodate a range of activities, from low-complexity and relatively low risk launches such as high-power rockets that do not reach the 100 km Karman line, to very complex, multi-stage, reusable orbital launch vehicles, as well as returns from space such as capsule landings.

The flexibility is achieved with regulations that are not prescriptive, in that they do not specify how an application must meet requirements. This means that the applicant has the ability to demonstrate the criteria have been met in a manner that matches the complexity and risk for their space activity. In essence, it is up to the applicant to prove the safety case to the regulator for their specific space activity, which can take different dimensions depending on the complexity of the activity. This can be explored by considering the safety case approaches for two scenarios of launches of different complexities.

In scenario one, a simple unguided, single-engine rocket launched on a range which completely encompasses the potential debris areas is considered a relatively low complexity, low risk event. Given the launch cannot breech the range, an applicant should be able demonstrate a safety case with fewer artefacts. Theoretically this safety case could be as simple as providing a plan to show that the range will be effectively kept clear of people for the operations, the safety analysis to show the debris is contained within the range, and the design information to demonstrate the rocket meets the parameters of the safety analysis.

In scenario two, consider a multi-stage rocket transiting areas outside a controlled range, which must use containment methods to meet the collective risk requirements for launch and return. In this scenario, detailed procedures are required for safety management at the launch site as well what will be done outside the range to maintain safety of the public where the rocket transits. Since containment is a requirement to meet safety criteria, detailed design information will be required for flight safety systems and the reliability of those systems must be proven. Additional information about the manufacture and test of the systems must also be provided to demonstrate the design criteria are met. Operational procedures, handling procedures, and the like will be required to demonstrate that the launch will occur in a way that matches the safety analysis. These are only some of the many aspects that must be considered for the complex scenario of a multi-stage orbital launch to ensure that the required safety standards will be met.

Like the scenarios above, the maturity and experience of an organisation can impact what is needed to demonstrate that the regulatory criteria are met. For an established organisation that has performed similar activities in the same location previously, some information to show that the previous personnel and processes have not changed is likely sufficient to demonstrate competence. For a new organisation operating with new systems in a new location, the application will need to describe in detail the organisational structure, how roles and responsibilities are handled, the interfaces to related parties for the activity, the qualifications and experience of key personnel to demonstrate their appropriateness in the role, and other information to convince the regulator that the activity can be conducted within safety requirements.

The adoption of a non-prescriptive approach allows applicants to use a wide range of reasonable approaches including novel techniques for demonstrating that the criteria are met. This includes the fact that, applicants may choose to use methodologies developed in other international regulations to demonstrate the Australian criteria are met, if they explain how their proposed method meets the Australian regulations.

The regulations also allow, in certain circumstances, for a formal Technical Recognition Instrument to be used, which is an instrument by which Australia recognises another country's licensing or certification of a launch facility or space object (launch vehicle). These options provide a level of consistency for international applicants seeking to perform space activities in Australia based on work they have done with their domestic regulator and allows flexibility for streamlining cross-border applications.

Beyond the structure of the regulations, the approach of the regulator is key. The space regulator, ASA's Office of the Space Regulator (OSR), strives to be flexible, approachable, and forward leaning. This is consistent with the dual role of the ASA to both encourage and regulate Australian space activities.

The regulator seeks engagement with applicants at an early stage in the application process and works with them throughout the process towards a successful outcome.

5. CHALLENGES & LESSONS LEARNED

Though Australian commercial space legislation has been effective in authorising a wide variety of activities [13], the implementation of the regulations has not been without some challenges and lessons learned.

For example, the General Rules initially had requirements for "an independent person" or a person who is "not a related party to the applicant" to provide assessments of cyber security and to perform the flight safety analysis (called a "Risk Hazard Analysis"). The requirements for these assessments to be performed by an independent or unrelated party were removed in a 2023 amendment, so the applicant now has the flexibility to engage an independent external party for these assessments or to demonstrate competence, and gain approval as required, to undertake this work themselves.

One of the biggest challenges for the regulations is the very thing that makes them flexible and able to apply broadly – the regulations are not prescriptive, so it can be challenging for new applicants to understand 'what good looks like'. As no business wants to do more work than is required, this can lead to a mismatch in the level of information submitted in an application and that required by the regulator, relying on the regulator to specify what additional information is required in an iterative assessment cycle.

This challenge can be compounded by the fact that the requirements specified in the Rules may be misinterpreted as a checklist for the application, rather than an information-set that should be submitted within a more holistic view of the safety approach When the Rules are predominately used as a checklist to generate artefacts, they tend to have slight misalignments based on which parts of the Rules they were developed for, leading to gaps in the documented safety case. For instance, information about operational safety controls may be developed as part of a Security Plan, a Management Plan, and an Emergency Plan which are all different elements of the Rules. If developed individually without a more holistic view, the three plans may duplicate, overlap, contradict each other or miss critical controls.

Unsurprisingly, current experience shows that not having a holistic safety approach when developing an application usually results in extensive requests for information from the regulator, leading to additional work for the applicant. This can lead to iteration or rework loops with the regulator which is not the most expedient method to develop a comprehensive safety case.

On the other hand, the most expedient applications are those that have looked holistically across the design, implementation, and operations of the space activity, having regard to the complexity and risk of the activity in the development of the safety case and operational approach. With this method, applicants then reference to the relevant part of the safety case and approach which meets a particular requirement of the Rules. This holistic approach ensures that the safety case is developed in a comprehensive way, with the intersections between design, implementation and operations aligned and carefully managed, which can then be clearly communicated to, and audited by, the regulator to verify no gaps exist.

Another lesson learned is around the application process. Initially the process was established based on a fee-charging approach, though the government has subsequently waived all application fees. Prior to the waiving of fees indefinitely, there was a defined fee-free period. This created a wave of applications submissions that were only partially complete in order to meet the fee-free period. As a response to this, the regulator agreed to conduct 'pre-reviews' to help applicants understand the gaps in the submissions. However, this prolonged the application process because it extended the iterative RFI and response loop described above, and ultimately created frustration in industry.

To combat these challenges and streamline the application process, the regulator has implemented several initiatives. First, the regulator engages early with applicants to understand the scope and complexity of the application, then set expectations of what is required, helping applicants to understand 'what good will look like' in the context of that specific space activity application. The goal of the early engagement is an understanding by both the regulator and the applicant of the requirements to develop a substantially complete and comprehensive application along with a plan for delivery to demonstrate that all criteria are met regarding the activity being proposed.

To achieve this, the regulator engages as early as possible with applicants to understand:

- the complexity of the applicable systems (launch facilities, launch vehicles, ground support equipment, payloads, etc.)
- the complexities of the mission(s)
- the current development phase of the systems
- the current development phase of the processes and procedures for the activity
- the experience, governance processes and certification of the applicant.

Given most applications are submitted while space objects (launch vehicles) or launch sites are in development, the applicant is asked to prepare a plan for

meeting the application requirements. As part of this early engagement, the regulator works with an applicant to understand and document the application plan and schedule, articulating what artefacts will be available at which stage, to demonstrate a comprehensive safety case with validated systems and complete activity procedures. Through this process the regulator helps elucidate what type of information is expected and at what level of detail to satisfy a safety case, based on the complexity and risk of an application.

The ASA has also worked to develop guidance resources for application submissions, which applicants are able to use for the development of complete application materials. Digital forms have been established for some applications, like those for Australians seeking an overseas payload permit, where the complexity is reduced when launching on an established international launch vehicle from an established launch site.

To ensure continuous improvement, at the end of each complex process, the regulator conducts retrospective exercises to capture what worked well and what could be improved. These exercises provide an opportunity for frank, respectful conversations between the regulator and applicant, and lead to improved relationships as well as iterating the approaches of the parties in future applications.

In keeping with the theme of flexibility, the regulator has also adapted its approach in line with increasing experience with the various types of applications. Further developing the regulatory body to support space launch and returns has required the growth and upskilling of the Agency and assessment teams. For example, the OSR has developed into a four-team organisation, which includes space regulation, regulatory engagement, regulatory operations and flight safety. In addition, capability has been developed around the appointed role of Launch Safety Officer and other Agency functions that support launch and return activities.

6. WHERE TO FROM HERE?

Going forward, there are several updates expected to streamline and simplify to the regulatory and guidance information for space and high-power rocket activities in Australia.

For instance, the Australian Government recently sought public consultation on proposed amendments for the *Space (Launches and Returns) (General) Rules 2019* and the *Space (Launches and Returns) (High Power Rocket) Rules 2019*. The proposed amendments cover:

- removing the three-stage application process for a launch facility licence
- reducing mandatory notification periods before a launch activity
- including further exceptions to the meaning of ‘accident’
- making other minor updates to the rules [14].

Additionally, an update to the Flight Safety Code is planned to remove ambiguity and better align with best practices globally.

The ASA is also working to develop guidance to address obligations under a recent treaty between Australia and the United States called the Technology Safeguards Agreement (TSA). This enables US space technology to be launched from Australia [15]. It is expected the TSA will make Australia more attractive as a global launch hub, and therefore, is likely to increase the cadence for launch and return activities in Australia in future.

The ASA also plans to release additional detailed guidance material to continue to clarify the requirements of the Rules. It is expected these guidelines will initially focus on key flight safety elements of the launch or return application, such as flight safety plans, flight safety analyses and flight safety system requirements.

Additionally, while the regulation does not currently account for human spaceflight, the ASA is responsible for all civil space matters, and the ASA is currently considering the future regulation of on Earth orbit operations and other space activities.

Beyond regulations and guidance materials, process and engagements are being adjusted to ensure the regulatory environment meets the needs of industry. As mentioned above, both applicants and the regulator have identified the criticality of early engagement to reach a common understanding of the planned space activity for streamlining the application process and timelines. New applicants are now asked to establish an application plan, outlining major design or project milestones, as well as expected artefact deliveries as the applications mature. The regulator is focused on improving this process with each application.

In addition, the ASA has also created a Space Regulation Advisory Collective (SRAC) which includes more than 250 non-government space sector representatives with an interest in space regulation. The ASA aims to hold up to four activities per year with the SRAC, each focusing on a different topic of interest to understand current needs and trends in space activities, as relevant to space regulation. Key questions are posed to the group, and information gathered by the ASA from industry representatives.

To date, the last two activities were focused on space resource use and on-orbit operations. This provides the ASA with an understanding of opportunities and pressure points domestically and enables sector views to be incorporated when the ASA represents Australia's interests in international forums.

Similarly, the ASA convened a flight safety workshop with Australian industry in June 2024 to collect feedback on challenges related to the design, manufacture and operation of flight safety systems in the Australian context, and the future of flight safety systems in Australia. The feedback gathered will be used to inform Flight Safety Code updates, as well as the development of flight safety system guidance material.

7. CONCLUSION

The legislative framework administered by the Australian Space Agency's Office of the Space Regulator, has built an environment for flexible, industry-focused space launch and returns in Australia.

While there have been some challenges, the OSR continues to refine its regulatory approach. Proposed and already released updates in the regulation, coupled with industry engagement, development of guidelines and a flexible approach to assessments has enabled the successful approval of many space launch and return activities and several launch facilities.

The ASA has worked to adjust support industry while meeting public safety and other regulatory requirements, while also supporting regular engagements to ensure continuous improvement.

The outcome of this revised legislation and approach is that Australia now has a strong spaceflight safety regime that is consistent with global best practice and regulation. The revised legislation and approach also have the flexibility to address a wide variety of emerging spaceflight activities in Australia, and the capability to support the ever-emerging spaceflight technologies of the future.

REFERENCES

1. "History of the Woomera Prohibited Area", Australian Department of Defence, accessed 14 Aug 2024, https://www.defence.gov.au/bases-locations/sa/woomera/about
2. Davis, M, "Special report: Australia's north and space", August 2023. Australian Strategic Policy Institute (ASPI), accessed 26 Aug 2024, available at: https://www.aspi.org.au/report/australias-north-and-space
3. Talmage, J and Maneice, D, "The True Size", accessed 12 Aug 2024, https://www.thetruesize.com
4. "Facts and figures on life in the European Union", European Union, accessed 12 Aug 2024, https://european-union.europa.eu/principles-countries-history/key-facts-and-figures/life-eu_en
5. "What Are the Contiguous United States?", World Atlas, accessed 12 Aug 2024, https://www.worldatlas.com/articles/what-are-the-contiguous-united-states.html
6. "Australia's size compared", Geosciences Australia, accessed 12 Aug 2024, https://www.ga.gov.au/scientific-topics/national-location-information/dimensions/australias-size-compared
7. Regional Population Grid 2022-23 interactive map, Australia Bureau of Statistics, accessed 12 Aug 2024, https://www.abs.gov.au/statistics/people/population/regional-population/2022-23
8. Dougherty, K, "Sixty years of Australia in space", *Journal & Proceedings of the Royal Society of New South Wales*, vol. 153, part 1, 2020, pp. 46–57, accessed: 14 Aug 2024, https://royalsoc.org.au/images/pdf/journal/153-1-Dougherty.pdf
9. "About the Agency: Who we are and what we do", Australian Space Agency, accessed 16 Aug 2024, https://www.space.gov.au/about-agency
10. Rabius, T, "Safety standards for launch and re-entry operations: Overview of current risk management policies in different countries and industries", *Journal of Space Safety Engineering*, 10 (2023) 331-339
11. "Guidelines on Permission Related to Launching of Spacecraft, etc.", March 30, 2018, Cabinet Office National Space Policy Secretariat, accessed 14 Aug 2024, https://www8.cao.go.jp/space/english/activity/documents/guidelines1.pdf
12. "Streamlined Launch and Reentry Licensing Requirements (SLR2) Rule", Federal Aviation Administration, accessed 16 Aug 2024, https://www.faa.gov/sites/faa.gov/files/space/additional_information/faq/SLR2_Final_Rule_450_2.pdf
13. "Minister decisions about space activities", List of decisions about space activities, Australian Space

Agency, accessed 12 Aug 2024, https://www.space.gov.au/minister-decisions-about-space-activities

14. "Space (Launches and Returns) (General) Rules 2019 and Space (Launches and Returns) (High Power Rocket) Rules 2019: stage 2 amendments", Australian Government Department of Industry, Science and Resources, accessed 16 Aug 2024, https://consult.industry.gov.au/space-launches-and-returns-rules-amendments-2
15. "Everything you need to know about the TSA", Technology Safeguards Agreement, Australian Space Agency, accessed 26 Aug 2024, https://www.space.gov.au/technology-safeguards-agreement-facts