# Title 14 Code of Federal Regulations Part 101 Aviation Rulemaking Committee (ARC)

*ARC Recommendations Report*

**December 2017**

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# 1. Executive Summary

Advanced technology has led to existing regulations governing unmanned free balloons (UFB) and moored balloons in 14 Code of Federal Regulations (CFR) Part 101 being outdated. As a first step in the review process, the Federal Aviation Administration (FAA) established an Aviation Rulemaking Committee (ARC) to provide a forum for industry input to develop recommendations on the safe operations of moored balloons and UFBs, and to consider whether the purview of Part 101 should be expanded to explicitly include fireworks, and sky lanterns and the use of hybrid devices in the National Airspace System (NAS).

The ARC met five times, beginning in January 2017, and developed the recommendations for, UFBs, fireworks and sky lanterns, and hybrids, which are summarized in Table 1, together with the rationale for the recommendation. The ARC could not develop recommendations for moored balloons due to the lack of data. Recommendations were grouped into two categories – priority recommendations which do not require rulemaking and rulemaking recommendations. Priority recommendations can be addressed with orders/procedures and should potentially be implemented in the near term.

The ARC members understand that if the FAA chooses rulemaking the implementation of any rulemaking recommendations must follow the public rulemaking procedures under the Administrative Procedure Act and is expected to be a longer-term undertaking. The ARC also understands that any change, regulatory or non-regulatory, that could impact NAS equipment, operations, or procedures will undergo a safety risk assessment in accordance with the FAA Safety Risk Management (SRM) policy to ensure they do not introduce unintended risk.

**Table 1. Summary of ARC Recommendations**

| Unmanned Free Balloons (UFBs) | | | |
|---|---|---|---|
| **ARC Charter Topic** | **Priority Recommendations** | **Rulemaking Recommendations** | **Rationale** |
| General recommendations | • Host a recurring FAA Part 101 Industry Forum to facilitate routine collaboration<br>• Undertake a safety risk assessment on current UFB operations in accordance with FAA SRM policy | • Adopt new UFB operator certification requirements | • Open, ongoing dialogue provides a way to collaboratively respond to a dynamic operational environment<br>• Acknowledge and assess the safety risk impact of mitigations and best practices in use by the community<br>• Ensure operators have the knowledge to safely conduct UFB operations in the NAS |
| Notice requirements | • Standardize information for FAA notice requirements<br>• Standardize Air Traffic Control (ATC) procedures for handling UFB operations<br>• Develop a methodology to uniquely identify UFB operations | • Require that UFB operators notify NAS users of planned operations prior to launch | • Standardize notice requirements and procedures to reduce coordination delay and ATC/ pilot confusion<br>• Increase situational awareness for all NAS users with improved UFB notification and identification |
| Equipment requirements | • None | • Require FAA-accepted surveillance for UFBs and provide assistance to educational institution programs<br>• Remove current requirement for radar reflective device(s) | • Ensure situational awareness for all operators in the NAS<br>• Remove ineffective rules if superseded by surveillance requirement |
| Size and weight | • In accordance with the FAA SRM policy, undertake study to reevaluate current Part 101 payload weight and weight/ size ratio thresholds | • None, but envision that the analysis might provide recommendations | • Additional data and analysis is needed before establishing new weight and size recommendations |
| Operating limitations | • None | • Evaluate current operating limitations based on weather conditions | • Need to determine if surveillance equipage can effectively mitigate risk in instrument weather conditions |
| Termination requirements | • None | • Update current requirements to be performance based, driven by safety considerations, and to be aligned with international regulations | • Revisions needed to align with safety and performance requirements, as well as the international community |
| **Moored Balloons** | | | |

| ARC Charter Topic | Priority Recommendations | Rulemaking Recommendations | Rationale |
|---|---|---|---|
| Size and weight | • Additional data collection and reconsideration of updates to Part 101 in 24 months suggested | | • No recommendations due to lack of data |
| Operating limitations; notice and equipment requirements | • Additional data collection and reconsideration of updates to Part 101 in 24 months suggested | | • No recommendations due to lack of data |
| **Fireworks and Sky Lanterns** | | | |
| **ARC Charter Topic** | **Priority Recommendations** | **Rulemaking Recommendations** | **Rationale** |
| Regulations | • Develop a methodology for accountability for the non-professional user | • Add the terms "fireworks" and "sky lanterns" to Part 101 General Section | • Formally recognize the risk these operations can pose to aviation |
| General recommendations | • Develop a public service announcement (PSA) for large, routine events<br>• Develop advisory circulars (AC) for fireworks and for sky lanterns | • None | • Provide consistent guidance to operators and enhance public awareness of potential risks to aviation |
| Notice requirements and authorizations | • Standardize and formalize internal FAA reporting procedures<br>• Provide operators access to appropriate means for notifying national airspace system (NAS) users | • Require that display fireworks and sky lantern event organizers must notify the FAA and NAS users of planned events in advance | • Notification needed to increase situational awareness for all NAS users<br>• Standardize procedures to reduce coordination confusion with FAA and allow for relationship with industry<br>• Establish baseline data collection, via consistent notification, for ongoing safety analysis |
| **Hybrids** | | | |
| **ARC Charter Topic** | **Priority Recommendations** | **Rulemaking Recommendations** | **Rationale** |
| Operating requirements | • Regulate by phase of flight and follow regulations for the vehicle type, and/or permit operations on a case-by-case basis | • None | • Ensure a pathway for operation in the NAS consistent with the risk posed by given operations |

# 2. Background

*Part 101 Regulatory Context*

The Part 101 ARC was sponsored by the Director of Airspace Services (AJV-1) to provide recommendations to the FAA concerning rulemaking to ensure the continued safe operation of moored balloons, unmanned free balloons (UFBs), fireworks, sky lanterns, and hybrid devices in the NAS.

The regulations in Part 101 regarding operations of moored balloons and UFBs were originally implemented in the early 1960s.[1] Over the last decade, rapid advancements in UFB technologies combined with a substantial increase in UFB activity related to a wide range of scientific, research, commercial, and recreational applications have highlighted the need to update Part 101 to reflect the current operating environment. Performance characteristics and operators of UFBs have also evolved significantly resulting in new categories of balloon activities. One example is hybrid operations which employ two or more flying devices such as UFBs used as an airborne platform to launch rockets. Fireworks and sky lanterns are not explicitly regulated by the FAA. The FAA is using the Part 101 ARC to explore the need to regulate this activity due to recent safety concerns with fireworks near major airports.

The Airspace Policy Group (AJV-11) hosted a two-day United States (U.S.) government stakeholder workshop in June 2015 to discuss emerging trends on UFBs, hybrid operations, fireworks, and sky lanterns. Top priority issues identified at this workshop were related to safety risk, lack of surveillance, and the need for updated definitions and rulemaking. FAA Air Traffic Organization Office of Safety and Technical Training (AJI) presented an analysis of safety data at this workshop. This workshop provided the impetus to reexamine current Part 101 regulations to assess the need for potential amendments. AJV-11's application to update Part 101 regulations was accepted in August 2015. The ARC Charter became effective as of May 23, 2016 and ARC meetings began in January 2017.

*Regulations and Research Efforts Relevant to the Part 101 ARC*

There are several noteworthy efforts pertaining to other new entrants in the NAS that are relevant to this ARC. These efforts include rulemaking activities as well as research that have helped inform this ARC or may be informed by this ARC in the near term. Some examples of these related efforts will be described here briefly.

In terms of recent rulemaking activities, the ARC took account of the upcoming mandatory requirement for Automatic Dependent Surveillance-Broadcast (ADS-B) mode in 2020 as well as Title 14 CFR Part 107, small Unmanned Aircraft System (sUAS) rule was implemented on August 29, 2016 to enable routine, low altitude sUAS operations subject to certain requirements related to the aircraft, pilot certification, and operating rules. Pilot certification requirements under Part 107 may be relevant to Part 101 UFB operations and were considered by the ARC during their deliberations. The FAA has also chartered the UAS in Controlled Airspace ARC focused on large UAS, which held its kick-off meeting in September 2017. Recommendations

[1] Amateur Rocket regulations, contained in Subpart C, were updated in 2008, and Subpart E, pertaining to Model Aircraft (a subset of unmanned aircraft) was added in 2016.

from the Part 101 ARC may help inform this UAS ARC of the unique aspects and challenges associated with Part 101 operations which also transit through controlled airspace and may have implications for UAS operations. Finally, International Civil Aviation Organization (ICAO) regulations for UFBs also helped inform ARC discussions.

Research efforts relevant to ARC discussions include encounter risk modeling research and findings presented at ARC meetings by The MITRE Corporation (MITRE) and findings associated with aircraft vulnerability to space vehicle debris presented by the FAA Office of Commercial Space. Additionally, research underway on UAS airborne collision severity through the FAA's Center of Excellence for UAS Research - Alliance for System Safety of UAS through Research Excellence may be of interest to the FAA due to its relevance in determining safety implications of UFB payloads and hybrid operations.

# 3. Objectives and Summary of Activities of the ARC

*ARC Objectives*

The FAA chartered the Part 101 ARC to "provide a forum for the United States aviation community and other NAS users to discuss, prioritize, and provide recommendations to the FAA concerning operations conducted under Part 101." The ARC was tasked with submitting a written report to the Director, Airspace Services (AJV-1) detailing the recommendations [1].

The ARC discussions and proposed recommendations to the FAA were informed by a set of questions for moored balloons, UFBs, fireworks, and sky lanterns. While not exhaustive, the Charter questions provide guidance for discussing key issues related to the applicability of Part 101 regulations, operational limitations, equipment and marking requirements, and notice requirements to be considered in rulemaking discussions. The Charter also includes a separate set of questions related to the assessment of costs and benefits of the proposed ARC recommendations to operators and other NAS users. The ARC examined potential impacts and benefits within the context of proposed recommendations and did not undertake a comprehensive cost and benefit assessment as that will be conducted as a part of the rulemaking process. A high-level summary of the ARC Charter questions is provided below; the Charter provides further details on these questions [1].

*ARC Charter Questions*

**UFBs and Moored Balloons**

1. Should moored balloons be regulated differently based on size and weight?
2. What additional operating limitations, notice requirements, or lighting and marking requirements should the FAA impose on moored balloons to ensure the safety of all users in the NAS?
3. Should unmanned free balloons be regulated differently based on size and weight?
4. What additional operating limitations should the FAA impose on unmanned free balloons to ensure the safety of all users in the NAS?

5. What additional equipment and marking requirements should the FAA impose on unmanned free balloons to ensure the safety of all users in the NAS?
6. What additional notice requirements should the FAA impose on unmanned free balloons?
7. When should an operator be required to terminate an unmanned free balloon operation?
8. To ensure the safety of all users in the NAS, what requirements should the FAA impose on operations that use balloons as airborne launch platforms to launch devices, such as unmanned aircraft systems, model aircraft, or rockets?

**Fireworks/Pyrotechnics and Sky Lanterns**

1. Should fireworks/pyrotechnics and sky lanterns be regulated?
2. What additional operating limitations should the FAA impose on fireworks/ pyrotechnics and sky lanterns?
3. What notice requirements and authorizations should the FAA impose on fireworks/ pyrotechnics and sky lanterns?

**Costs and Benefits of Proposed Recommendations**

**1.** As it relates to the ARC recommendations in the final report, what are the costs and benefits of the recommendations?

*ARC Membership and Structure*

The FAA selected and established a committee consisting of a diverse group of current Part 101 operators and other stakeholders based on their familiarity with and likelihood of being impacted by Part 101 operations. The ARC membership includes current Part 101 operators and manufacturers, aviation associations, industry groups, and academia. The committee also includes operators and industry associations for fireworks/pyrotechnics and sky lanterns.

The ARC Members and U.S. Government affiliates include:

- Airlines for America
- Aircraft Owners and Pilots Association
- Airlines Pilot Association
- American Pyrotechnics Association (APA)
- Fireworks Production of Arizona
- Google X, Inc.
- Graham Aerospace International (Industry Co-Chair)
- Helicopter Association International
- Lantern Fest
- Maverick Civilian Space Foundation

- Montana Space Grant Consortium, Montana State University
- National Aeronautics and Space Administration (NASA)
- National Air Traffic Controllers Association (NATCA)
- National Business Aviation Association
- National Fire Protection Association (NFPA)
- National Fireworks Association
- National Oceanic and Atmospheric Administration/National Weather Service (NWS)
- Near Space Corporation
- Radio Technical Commission for Aeronautics
- Raven Aerostar, Raven Industries
- U.S. Navy
- World View Enterprises

*Summary of ARC Meetings and Actions*

The ARC conducted five meetings between January 2017 and November 2017 to facilitate discussions and deliberations on the ARC Charter and to develop recommendations. The ARC kick-off meeting was hosted by MITRE in McLean, VA from January 11-12, 2017. It focused on providing an overview of ARC objectives, establishing ARC procedures, and facilitating industry data collection to support ARC deliberations. This first meeting included a series of presentations intended to provide a comprehensive overview of the regulatory, operational, and safety considerations around Part 101 operations of interest, fireworks, and sky lanterns. Appendix A lists all the presentations provided at ARC meetings.

The second ARC meeting was hosted by X, a subsidiary of Alphabet Incorporated, in Mountain View, California from February 7-8, 2017. It focused on initiating discussions and deliberations on ARC Charter questions on UFBs and developing a preliminary list of proposed amendments to the current Part 101 regulations pertaining to UFBs. This meeting also included a tour of X facilities and a balloon testing demonstration at NASA Ames Research Center at Moffett Field, California.

World View Enterprises hosted the third ARC meeting in Tucson, Arizona from March 23-24, 2017. Key activities of the third meeting included discussions on ARC Charter questions related to fireworks and sky lantern operations, and continued discussion on proposed modifications to the current Part 101 regulations for UFBs. Additional topics covered included an analysis of FAA Mandatory Occurrence Reports (MOR)[2] data for UFBs and fireworks, and an overview of Part 107 pilot certification requirements. This meeting also included a tour of the World View facilities.

[2] FAA Order JO 7210.632, Air Traffic Organization Occurrence Reporting requires submission of MOR for defined incidents by ATC personnel. These are entered in to the Comprehensive Electronic Data Analysis and Reporting tool (CEDAR).

The fourth ARC meeting was hosted by Raven Industries in Sioux Falls, South Dakota from May 23-24, 2017. This meeting led to the development of draft recommendations for fireworks and sky lanterns. Draft recommendations were also developed for UFBs, however, the ARC identified some gaps with the proposed UFB recommendations that would need further discussion. The meeting also included a university balloon launch demonstration facilitated by students and staff of Montana State University's Space Grant Consortium sponsored by NASA.

The final meeting of the ARC was held on July 11, 2017 at MITRE in McLean, Virginia. The final meeting was focused on finalizing draft ARC recommendations for UFBs. The ARC also discussed the challenges with developing recommendations for moored balloons and hybrids given limited operational and safety data. The fifth meeting concluded the in-person deliberations and discussions for the ARC with the remainder of the ARC activities being dedicated to the drafting and refinement of this ARC report. The ARC held one telecon on September 25, 2017 to discussion comments received on the draft recommendations compiled during the July ARC meeting.

# 4. ARC Recommendations

This section outlines ARC recommendations, groups into two categories – priority recommendations and rulemaking recommendations. Priority recommendations do not require rulemaking and the ARC believes they should be implemented in the very near term. Examples of priority recommendations include updates to FAA policy and procedures, issuance of advisory circulars, establishment of collaborative industry forums, etc.

For rulemaking recommendations, the ARC understands that the FAA will follow the public rulemaking procedures under the Administrative Procedure Act [2]. Title 14 CFR Part 11 provides further details on the FAA rulemaking process; this process is also subject to requirements imposed by Executive Orders such as EO 13771: Reducing Regulation and Controlling Regulatory Costs and EO 13777: Enforcing the Regulatory Reform Agenda. Rulemaking recommendations in this report are focused on new rules as well as modifications to existing Part 101 regulations. For new rules, the ARC examined preliminary impacts and benefits within the context of proposed recommendations. Preliminary impacts and benefits of the rulemaking recommendations are qualitative in nature. They are based solely on ARC members' inputs and focused on incremental impacts relative to current practices, as per guidance from the FAA Office of Aviation Policy and Plans (APO-300). The ARC understands that a rigorous assessment of the impacts and benefits will be considered as part of the rulemaking process.

The ARC also understands that any change, regulatory or non-regulatory, that could impact NAS equipment, operations, or procedures will undergo a safety risk assessment in accordance with the FAA SRM policy to ensure they do not introduce unintended risk.[3] The ARC assumes that cross-references to any affected procedures or regulatory changes will also be updated (such as the Aeronautical Information Manual).

[3] FAA Air Traffic Organization Safety Management Manual, Version 4.0.

The remaining sections of this report discuss the priority and rulemaking recommendations by operation type, in the following order – UFBs, moored balloons, fireworks, sky lanterns, and hybrids.

# 4.1. Unmanned Free Balloons

This section provides a brief background on UFBs, followed by priority recommendations, and rulemaking recommendations and associated preliminary impacts and benefits.

## 4.1.1. Background

*Operational Overview and Safety Implications*

UFBs represent a wide range of balloon sizes and performance characteristics. They are also utilized for a variety of applications as a cost-effective platform to access upper reaches of the atmosphere, greater than 50,000 feet (ft) above mean sea level. Common applications for UFBs include science, technology, engineering and mathematics educational programs, weather data collection and research. Additionally, UFBs are also expected to be used in commercial applications such as remote sensing, surveillance, communications, and provision of internet connectivity.

UFBs can be grouped into three categories with distinct performance characteristics – sounding balloons, zero pressure balloons, and super pressure balloons. Sounding balloons, typically used for short duration missions, expand as they rise through the atmosphere, reaching altitudes of over 100,000 ft before bursting and thereby terminating the balloon flight. Sounding balloons can be launched relatively easily on short notice and are generally low cost. The NWS uses sounding balloons to collect atmospheric data; sounding balloons are also frequently used by educational programs to conduct scientific experiments.[4]

Zero and super pressure balloons are both used for long duration missions and can carry large payloads, weighing up to 8000 pounds (lbs). However, zero pressure balloons are vented and therefore change altitude with temperature changes requiring the release of ballast to maintain height, which limits the duration of the flight. Super pressure balloons are sealed and can support missions in excess of 100 days. Both of these balloon types require the use of specialized equipment for launch and involve higher costs than sounding balloons. NASA and commercial industry operators typically deploy zero and super pressure balloons for scientific experiments and commercial applications.

ARC members provided data on the current number of UFB operations per year along with details on payload weight, dwell duration, and balloon envelope size, as reported in Table 2. Table 3 provides estimates of *projected* UFB activity for the different operator groups. Note that these estimates were provided by ARC members to inform ARC discussions.

[4] Here, educational programs refer to programs that use UFBs for instructional purposes, such as UFB programs undertaken by non-profits, universities, and high schools, and college space grant consortiums.

**Table 2. UFB Operational Information from ARC Members**

| Operator group | Total number of launches per year | Payload weight range (lbs.) | Dwell duration* | Range of diameter at maximum envelope (ft) |
|---|---|---|---|---|
| **NASA** | 13-18 | Up to 8000 | Hours - Days | 460 |
| **Industry** | 600-700 | 0.1-1000 | Hours - Days | 7-200 |
| **NWS** | 70,000 | 0.2-0.681 | < 1 Hour | 20 |
| **Educational Programs (heavier payloads)** | 30 | <30 | Minutes to Hours | 14-43 |
| **Educational Programs (lighter payloads)** | 700 | <12 | Minutes to Hours | 14-43 |

* Dwell time noted in this table primarily pertains to duration spent while above 60,000 ft MSL.

Based on ARC member inputs, an estimated 376,500 UFBs were launched over the last five years (2012-2016). During the same period, there were a total of 452 million NAS operations.[5] As indicated in Table 2, the size, payload weight, and performance characteristics of UFBs launched by educational programs differ significantly from those launched by NASA and industry. Here, industry refers to commercial UFB operators such as X, World View, and Near Space Corporation, who were ARC members. Educational programs tend to use smaller balloons, with little to no dwell time, that carry payloads of less than 30 lbs. The majority of these operations fall below the applicability criteria specified by Part 101. However, launch numbers for these types of balloons are on par with NASA and industry launches and these operations may still pose an aviation safety risk. NWS launches a significant number of UFBs per year as a part of their weather balloon program. However, given the low payload weight, they are not required to comply with the requirements detailed in Subpart D. In fact, any operator group can potentially launch UFBs carrying payloads below the current Part 101 payload weight thresholds to avoid Subpart D requirements. In terms of projected future activity, initial estimates listed in Table 3 indicate no growth in operations for NWS, modest increase in NASA operations, and a sizeable increase in industry operations.

[5] Terminal Operations include all take-off and landings at airports serviced by Air Traffic Control Towers and aircraft transiting approach control airspace. Operations at non-controlled airports are excluded.

**Table 3. Projected UFB Operations by Operator Group**

| Projected total number of launches per year | | |
|---|---|---|
| ***Operator group*** | ***Next 5 years*** | ***Next 10 years*** |
| NASA | 22-26 | 22-26 |
| Industry** | 2200 | 4300 |
| National Weather Service | 70,000 | 70,000 |
| Educational Programs | 730 | 730 |
| (**) Industry estimates include worldwide operations; however, most are launched from the U.S. | | |

MOR data involving UFBs were also evaluated over the same five-year period to inform ARC discussions. FAA Order 7210.632 mandates air traffic control (ATC) facilities to report any suspected loss of separation between aircraft and other objects or terrain, Traffic Alert and Collision Avoidance System (TCAS) events, emergency situations (such as pilot disorientation), and laser light illuminations. Any expression of concern or inquiry related to proximity or operation of aircraft, including near mid-air collision notifications are filed as MORs in the CEDAR database. Therefore, incidents that do not result in damage to aircraft, but constitute a hazard, are included in MORs. Table 4 provides additional details on the number of reports by hazard type derived from MOR data on UFBs.

**Table 4. 2012-2016 MOR Data on Hazards and Number of Incidents for UFBs**

| Hazard | Number of Incidents |
|---|---|
| Collision or balloon ingest | 17 |
| Pilot distraction, no evasive action, UFB within 100 ft of aircraft or NMAC* | 4 |
| Pilot distraction, no evasive action, UFB within 500 ft of aircraft or NMAC | 5 |
| NMAC | 9 |
| Pilot evasive action or TCAS Resolution Advisory | 15 |
| Pilot distraction, within 500 ft | 112 |
| Controller workload increase | 6 |
| **Other** | **3** |

(*) Near Mid-Air Collision

As indicated in Table 4, there were 17 collisions between balloons and manned aircraft from calendar years 2012-2016; four to five of the collisions were reported to involve "large" balloons. However, none of those collisions resulted in damage.

*Current Regulations*

All domestic UFB operations in navigable airspace fall under the FAA's jurisdiction, however, only UFB operations that meet payload weight or suspension criteria specified by Part 101 are required to comply with Subpart D of Part 101. Subpart D is divided into five sections: applicability (§101.31), operating limitations (§101.33), equipment and marking requirements (§101.35), notice requirements (§101.37), and balloon position reports (§101.39). While Part 101 regulations specify notice requirements for UFB operations, ARC members noted that coordination and notification procedures vary significantly by facility, which may impact timely dissemination of information to ATC personnel and other NAS users.

ICAO regulations for UFBs have similar requirements. These regulations can be found in Appendix 5 of Annex 2, Rules of the Air [3]. ICAO classifies UFBs into three different categories, light, medium and heavy. The majority of the operating limitations and requirements only apply to heavy balloons; including the use of transponders and transmitters. One notable difference between U.S. and ICAO regulations is that ICAO requires appropriate authorization for any balloon launch, whereas the U.S. only requires notice from a defined subset of UFB operations. Additionally, ICAO is currently in the process of establishing separation requirements between manned aircraft and UFBs through the ICAO Separation and Airspace Safety Panel. FAA procedures for handling UFBs are contained in Special Flights Chapter 9, Section 6 of the FAA JO 7110.65. The procedures suggest separation but do not provide specific vertical and lateral distances.

*Examples of Best Practices*

Over time, the UFB community has adopted many best practices to ensure a safe and successful mission. Some of these practices along with the concern they address (in parenthesis) include:

- Use of transponders compatible with ATC (secondary) surveillance[6] (situational awareness)
- Issuing of Notice to Airmen (NOTAMs) for payload and balloon carcass (situational awareness)
- Payload recovery and tracking (risk reduction and environmental concerns)
- Notification to air traffic facilities and airspace users of intended operation (including U.S. Department of Defense) via NOTAM and email (situational awareness and risk reduction)
- Close coordination and collaboration with the associated en route ATC facility (situational awareness and risk reduction)
- Availability of online, real-time UFB tracking information (situational awareness and risk reduction)

### 4.1.2. ARC Recommendations for Unmanned Free Balloons

This section documents priority and rulemaking recommendations for UFBs. As noted previously, priority recommendations are not expected to involve the rulemaking process and the ARC strongly advocates immediate implementation of these recommendations. Rulemaking recommendations include both new rules and modifications to existing regulations under Part 101.

*Priority Recommendations*

ARC priority recommendations noted below were focused on improving the current understanding of safety risks associated with UFBs and on standardization of coordination procedures to improve awareness of UFB activity for ATC facilities and NAS users.

- General Recommendations: As the UFB industry does not have an association to work collaboratively with the FAA to improve safety and reduce risk, the FAA should host a recurring Part 101 Industry Forum to facilitate routine collaboration between the FAA and Part 101 operators, completely independent of rulemaking activities.

The FAA hosts industry forums to provide routine updates to industry and collect feedback from NAS users and other stakeholders on the topic of interest. Given the lack of an industry association or community-based organization for UFB operators, the ARC recommended that the FAA establish an industry forum for routine communication, and collaboration to improve safety and reduce risk. The FAA and operators understand that this group should not discuss any rulemaking recommendations or considerations. It was also noted that the Part 101 operators

[6] While transponder use can significantly improve situational awareness for ATC, lack of discrete beacon codes for UFBs may lead to confusion and increased ATC workload.

could benefit from participating in the existing quarterly NOTAM stakeholder meeting. The FAA agrees to hold the first industry forum in the Spring of 2018.

- General Recommendations: The FAA should undertake a safety risk assessment on the current status of UFB operations in accordance with FAA SRM policy to assess potential benefits resulting from voluntary mitigations already in place.

As noted previously the UFB community has a number of best practices related to equipage, notification, and operating procedures to promote safe operations. This recommendation is aimed at characterizing aviation safety risk associated with UFBs while taking into consideration voluntary mitigations already adopted by operators.

- Notice Requirements: The FAA should organize a very near-term collaborative activity with UFB operators to standardize information needed for FAA notice requirements.

While Part 101 specifies notice requirements for UFB operators, in practice, notification and coordination procedures can vary significantly across the NAS. The ARC recommended development of a "Float Plan" format specific to UFBs, such that the format allows for uncertainty in balloon trajectory.

- Notice Requirements: The FAA should develop and promulgate standardized ATC procedures for handling UFB operations throughout the NAS.

ARC discussions revealed discrepancies in how ATC currently handles UFB operations. Some FAA facilities and UFB operators were in constant communication and kept their respective constituencies informed of UFB activities. In other facilities, there was less communication and coordination, which can lead to confusion, increased workload, and safety concerns. Examples of standardized procedures recommended by the ARC include coordination guidelines for UFB operators, points of contact, information requirements, and timelines. The ARC requests the FAA identify and evaluate current ATC procedures to determine what, if any, modifications are necessary. This may involve the FAA working in collaboration with NATCA, to train facility personnel on the standardized procedures. The FAA agrees to bring these procedures to the first Part 101 Industry Forum, to be held in the Spring of 2018.

- Notice Requirements: The FAA should develop a methodology to uniquely identify UFB operations.

Currently, UFB operations are not assigned discrete beacon codes, which can lead to confusion, ATC workload challenges, and safety issues as UFB operations continue to grow. The unique identifiers for balloons should be reusable once a given balloon flight is terminated. In the near term, this could be potentially achieved through hexadecimal Mode S transponder codes, but in the long term a different solution may be more effective.

- Size and Weight: In accordance with the FAA SRM policy, the FAA should conduct further study to reconsider the maximum potential payload weight, balloon size, and materials density that meet acceptable level of safety without proposed mitigations/ rules.

The ARC was not able to provide recommendations on updates to current Part 101 payload weight and weight/size ratio thresholds due to lack of research supporting specific thresholds. The ARC strongly recommended that the FAA should place a priority on establishing revised payload weight, balloon size, and materials density thresholds as a formal change to the new Part 101 regulations. The group proposed that this analysis be conducted in the very near term in accordance with the FAA SRM policy.

*Rulemaking Recommendations*

Rulemaking recommendations were aimed at leveraging current best practices adopted by UFB operators by formalizing them into regulatory requirements. The ARC recommended new rules as well as modifications to existing rules under Part 101.

- General Recommendations: The FAA should adopt new UFB operator certification requirements tailored to the UFB community analogous to the 14 CFR Part 107 remote pilot in control requirements.

Certification requirement for UFB operators could be similar to the remote pilot requirements in 14 CFR Part 107 with appropriate modifications to reflect operating conditions for UFBs. Impacts of this new requirements include additional costs for UFB operators. A key benefit of this potential new rule would be that operators will possess the requisite knowledge to safely conduct UFB operations in the NAS.

- Notice Requirements: The FAA should adopt a new requirement that UFB operators should notify NAS users of planned operations prior to launch.

In the near-term this could be accomplished via the NOTAM system, but in the future it could be an alternative system.[7] Part 101 currently has notice requirements for regulated UFB operations that mandate that the operator should notify the FAA of proposed operations, however, there are no requirements to notify other NAS users. Notice practices for UFB operations vary across the NAS where NOTAMs may or may not be filed depending on the location. Based on ARC discussion, this new requirement is likely to pose minor costs for operators. A key benefit of this requirement is standardization of the notice requirement, which will reduce coordination delays, decrease ATC and pilot confusion, and improve situational awareness for all NAS users.

- Equipage Requirements: The FAA should create a new rule that requires FAA-accepted surveillance for UFBs and air traffic services, appropriate for the airspace, and provide some type of assistance to educational institution programs to comply with equipage requirements.

[7] Although this issue was not discussed during the meeting itself, NATCA requested that the following be appended to the NOTAM recommendation: NATCA is concerned that the increased volume in the NOTAM system, as a result of the above recommendation, could have adverse, unintended consequences on the NOTAM system, which is both (1) an insufficient safety mitigation tool, and (2) an unreliable notification tool. The NOTAM system has known systemic problems and is the subject of two of the five topics on the Air Traffic Organization's Fiscal Year 2017 "TOP 5" list because of these and other issues associated with the system. Therefore, NATCA believes that the NOTAM system is best used as an "advisory" system only and that it should not be relied on for safety mitigation without significant improvements to the current NOTAM system.

The ARC recommended that some means of secondary surveillance be required on UFB operations that fall under the current Part 101 applicability criteria. The secondary surveillance equipment may be Mode S transponders, ADS-B out, or some other FAA-accepted equipment.

Impacts on Part 101 operators resulting from this potential rule were discussed by the ARC and are expected to vary by operator group. Many industry operators have already invested in transponders so the preliminary impact of a regulatory change may not result in additional costs for them. However, educational institution programs currently do not routinely use surveillance equipment and as such this rule is likely to result in additional costs for this operator group. Educational institution programs typically operate low cost missions and may face challenges accommodating additional costs imposed by this new requirement. The ARC recommended that if this rule is implemented, the FAA should provide assistance to educational institution programs to help them equip with FAA-accepted surveillance. Examples of assistance include providing Research and Development (R&D) educational funding, phasing the requirements for this community over time, etc. Potential benefits resulting from this requirement include situational awareness for all NAS operators and reduced controller workload. A safety assessment should be conducted to determine if surveillance equipage can also be a potential mitigation for enabling UFB operations in instrument meteorological conditions (IMC).

- Equipment Requirements: The FAA should remove the current requirement for radar reflective device(s) under §101.35 (3), subject to the new FAA required surveillance rule proposed by the ARC.

If the FAA adopts the rule on surveillance equipage proposed by the ARC (see UFB Rulemaking Recommendation 1), the ARC recommended removal of the current radar reflective device(s) requirements. Based on ARC discussions, it was found that the current effectiveness of these devices is questionable due to the low speed profiles of UFBs. Many radar processing systems filter out objects that are below a given speed threshold as this reduces radar clutter from fixed objects. If UFBs fall below the speed threshold of these systems, they may not be visible on ATC displays.

- Operating Limitations: The FAA should evaluate current operating limitations based on weather conditions as listed in §101.33 (b) and (c).

Several ARC members expressed concern that the current operating limitations related to weather conditions are restrictive to their operations. For example, current regulations related to weather conditions as defined in §101.33 (b) and (c) restrict Project Loon operations by as much as 30 percent. It was also noted that UFB operations under cloudy conditions and poor visibility may pose a safety risk to non-cooperative manned traffic. ARC recommendations on FAA-accepted surveillance, operator certification, and standardization of notification and coordination procedures may help alleviate these safety risks. The ARC recommended that the FAA should evaluate the feasibility of UFB operations in IMC through a safety assessment in accordance with the FAA SRM policy. This assessment also ensures that other existing rules are not impacted by any proposed changes to §101.33 (b) and (c).

- Termination Requirements: The FAA should update current payload cut-down and termination requirements outlined in §101.35 to be performance based, driven by

safety considerations, and to be aligned with international regulations to the extent possible.

The ARC recommended that the current termination and cut-down payload regulations outlined under §101.35 (sections (a) (1) and (2) and associated requirements) should be simplified to be performance based and should allow for coordination with ATC to determine when cut-down or termination is warranted. In particular, the ARC recommended that the current weather-related restrictions for cut-down and termination systems should be removed and that safety considerations should drive the decisions on payload cut-down and termination. Additionally, the ARC also recommended that current Part 101 payload cut-down and termination requirements be aligned with international regulations (ICAO Annex 2, Appendix 5) to the extent possible to harmonize requirements globally.

## 4.2. Moored Balloons

Moored balloon regulations can be found in Subpart B of Part 101. These regulations apply if a moored balloon meets the size or capacity criteria under Part 101. Moored balloon activity is typically associated with military operations (i.e., aerostats), or promotional campaigns (e.g., car dealerships). There are also proposals for moored balloons with unique characteristics like 20,000-foot cables with controlling wings used as aerial wind energy systems. No separation standards exist for moored balloons as they usually are suspended close to the ground (below 150 ft), or are wholly contained in special use airspace. No safety incidents have been reported for commercial moored balloons.[8] Due to insufficient data, the ARC could not make any priority or rulemaking recommendations for moored balloons. The ARC suggested additional data collection on moored balloons and that the FAA reconsider updating Part 101 for moored balloons in 24 months.

## 4.3. Fireworks and Sky Lanterns

The following sections provide a brief background on fireworks and sky lanterns, followed by priority recommendations, and rulemaking recommendations and associated preliminary impacts and benefits for fireworks and sky lanterns.

### 4.3.1. Background on Fireworks

*Industry Overview*

The Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) groups fireworks into three categories – display fireworks, consumer fireworks, and articles pyrotechnic. Display fireworks are large fireworks typically used in fireworks display shows such as Fourth of July events. Consumer fireworks are small fireworks intended for use by the public, examples include fountains, cones, and firecrackers. Finally, articles pyrotechnic are devices meant for professional use, similar to consumer fireworks in chemical composition and construction but not intended for consumer use. ARC discussions were primarily focused on priority and

[8] In 2015 a surveillance balloon, located in Aberdeen Proving Ground, broke free of its moorings and drifted across Maryland and Pennsylvania. No injuries were sustained, either in the air or on the ground, however 35 property damage claims resulted from this incident. Provisions for ATC handling of derelict balloons have been added to the FAA JO 7110.65.

rulemaking recommendations for display fireworks. However, the ARC also considered safety implications of consumer fireworks for aviation and provided recommendations as deemed appropriate for this category. Articles pyrotechnic were not explicitly discussed during the ARC meetings since they are similar in composition and construction to consumer fireworks.

Based on the inputs provided by ARC members, there were a reported 175,000 display fireworks shows in the NAS, averaging at 35,000 shows annually, between January 2012 and December 2016. MOR data involving fireworks were also evaluated over the same five-year period to inform ARC discussions. Table 5 provides additional details on the number of reports by hazard type derived from MOR data on fireworks.

**Table 5. MOR Data on Hazards and Number of Incidents for Fireworks**

| Fireworks by Hazard | Number of Incidents |
|---|---|
| Pilot Distraction Collision – No Damage | 2 |
| Pilot Distraction – Fireworks within 500 ft (flight crew) | 6 |
| Pilot Evasive Action – within 500 ft | 1 |
| Pilot Evasive Action | 8 |
| Pilot Distraction Aimed at Aircraft | 14 |
| Pilot Distraction- Fireworks farther than 500 ft | 29 |
| Increase in Controller Workload – Aircraft Diverted Away from Fireworks | 3 |
| Other | 2 |

As indicated in Table 5, there were two collisions with manned aircraft but they were not associated with display fireworks; rather, they were single projectiles and did not cause damage. Similarly, the reports of fireworks being aimed at aircraft were not associated with display fireworks. Majority of reports involved pilots being distracted by fireworks with no evasive actions taken.

*Current Regulations*

The FAA does not currently regulate fireworks. At the federal level, key regulatory authorities for the consumer and display fireworks industry include the Bureau of Alcohol, Tobacco, Firearms, and Explosives and the U.S. Consumer Product Safety Commission. Title 27, CFR Part 555 requires any persons engaged in importing, manufacturing for commercial use, transporting, using, or otherwise receiving display fireworks to obtain a federal license or permit [4]. The U.S. Consumer Product Safety Commission has mandatory safety regulations for fireworks devices that pertain to the production, manufacturing, distribution, and sale of fireworks and pyrotechnics [5].

From an operational and aviation standpoint, consumer and display fireworks are regulated mainly by state and local authorities. Key state level authorities include State Fire Marshals and State Police. APA, the lead trade association for display fireworks, maintains a Directory of State Laws that shows how regulations vary by state. In most states, display fireworks require applications to be filed with state authorities 2 to 30 days before the proposed launch date.

Internationally, the United Kingdom's CAP 736 provides guidance on safe operations of fireworks displays and other aircraft (toy balloons and sky lanterns) by commercial organizations and individuals.[9] The Civil Aviation Rules Part 101 of New Zealand's Civil Aviation Authority

[9] U.K. Civil Aviation Authority. (2011). *Cap 736, Operation of Directed Light, Fireworks, Toy Balloons and Sky Lanterns within UK Airspace*, Directorate of Airspace Policy, United Kingdom Civil Aviation Authority, [Online]. Available: https://publicapps.caa.co.uk/docs/33/CAP736.PDF

establishes operating rules for aerial fireworks, which are considered to be a type of rocket.[10] Furthermore, Civil Aviation Rules Part 77 prescribes notification and rules for using pyrotechnics and other articles that may create hazards in the New Zealand airspace.[11] Similarly, Australia's Civil Aviation Safety Authority regulates the operations of pyrotechnic displays under Civil Aviation Safety Regulations Part 101.[12,13]

*Examples of Best Practices*

While there are best practices and standards associated with several aspects of fireworks such as manufacturing, transportation, and distribution, this discussion is focused on the operation of fireworks. APA-developed guidance helped inform the NFPA 1123, Code for Fireworks Display, which is an industry consensus code for the construction, handling, and use of fireworks and equipment for and the operations of outdoor fireworks displays. This code recommends that the operator should seek FAA approval when displays are planned in the vicinity of commercial airports and heliports and that the operator should issue a NOTAM to alert other NAS users of the event. Thresholds on proximity to airports and heliports are based on guidance provided by the authority having local jurisdiction.

Current best practices and voluntary measures associated with display fireworks were also shared with this ARC by APA and the Fireworks Productions of Arizona, a fireworks event company, during the March 2017 ARC meeting in Tucson, AZ. The display fireworks industry members routinely maintain contact with the FAA regarding operations. To maintain operational safety, industry members voluntarily send notifications letters to the FAA for planned display fireworks events which include date, time, and altitude of proposed operations. In some cases, the FAA issues a non-objection letter for the particular event; the operator then notifies the appropriate flight service station about the event and the flight service station files a NOTAM and makes coordination calls to the appropriate air traffic control tower. However, there are currently no standard practices or requirements on notification regarding display fireworks to the FAA or on how the information received is handled by the FAA. As such, the FAA internal procedures associated with handling voluntary notification information for display fireworks vary across the NAS.

The APA also publishes tips, videos, and public safety advisories on how to safely handle consumer fireworks. In addition, there are PSAs on fireworks issued through several venues such as local police and fire departments, the NFPA, etc. The APA states that despite unprecedented

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[10] CAR Part 101 also applies to other aircraft, including moored balloons, kites, free balloons, rockets (other than aerial fireworks), remotely piloted aircraft, control line model aircraft, free flight model aircraft, gyrogliders and parasails. For more information see *Civil Aviation Rules (CAR) Part 101, CAA Consolidation, Gyrogliders and Parasails, Unmanned Aircraft (including Balloons), Kites, and Rockets –Operating Rules,* Civil Aviation Authority of New Zealand, March 10, 2017, [Online]. Available: https://www.caa.govt.nz/assets/legacy/rules/Rule_Consolidations/Part_101_Consolidation.pdf

[11] Civil Aviation Authority of New Zealand. (2014). *Civil Aviation Rules (CAR) Part 77, CAA Consolidation, Objects and Activities Affecting Navigable Airspace*, Civil Aviation Authority of New Zealand, April 1, 2014, [Online]. Available: https://www.caa.govt.nz/assets/legacy/rules/Rule_Consolidations/Part_077_Consolidation.pdf

[12] CASR Part 101 also regulates operations of unmanned moored balloons and kites, unmanned free balloons, unmanned rockets, remotely piloted aircraft (RPA), and model aircraft.

[13] Civil Aviation Safety Authority of Australia. (2017). *Civil Aviation Safety Regulations 1998, Statutory Rules No. 237, 1998 made under the Civil Aviation Act 1988*, Volume 3 (Amended: March 2016), [Online]. Available: https://www.casa.gov.au/standard-page/casr-part-101-unmanned-aircraft-and-rocket-operations

growth of the fireworks industry, fireworks related injuries have dramatically declined over the last ten years partly as a result of industry safety education efforts and best practices. Injuries were 43 percent lower in 2016 relative to 2000. The decline in injuries are contemporaneous with an increasing number of states' and municipalities' relaxation of fireworks laws [6].

## 4.3.2. Background on Sky Lanterns

*Industry Overview*

The 2015 International Fire Code defines a sky lantern as "an unmanned device with a fuel source that incorporates an open flame in order to make the device airborne" [7]. In the U.S. the sky lantern industry is a relatively new venture with a growing public interest in large events and festivals featuring sky lanterns. As such there is currently no industry association for sky lanterns.

This report refers to large, coordinated events or festivals for sky lanterns as sky lantern events to differentiate from recreational use of sky lanterns by the general public. Lanterns used at events can rise anywhere from 600-700 ft to 1200 ft depending on weather conditions such as temperature, humidity, and winds. During ARC discussions, Lantern Fest estimated that over the period of five years from 2012 to 2016, there have been about 50 sky lantern events that involved launching approximately 500,000 lanterns. MOR data between 2012 and 2016 showed no incidents related to sky lanterns. Lantern Fest also noted that the sky lantern industry is not expected to grow rapidly as operations are currently limited by state and/or local regulations due to concerns about sky lanterns being a fire hazard.

*Current Regulations*

Sky lanterns are heavily regulated by state and local authorities. According to *Wildfire Today*, 29 states in the U.S. have banned the operations of sky lanterns [8]. An update to the same article noted that on February 18, 2016 Nebraska passed a bill unanimously banning the use of sky lanterns in the state due to potential safety risks. More recently, Alaska also banned sky lantern operations in the state [9]. In states that permit sky lantern operations, event organizers typically coordinate with the local authorities to obtain a permit for the event, similar to the process followed for display fireworks. However, given the lack of standardized procedures for sky lanterns, operators follow local safety and notification practices as appropriate. The FAA currently does not regulate sky lanterns.

*Examples of Best Practices*

Given the absence of consistent coordination and notification requirement for sky lanterns, operators have established internal best practices to ensure safe operations. Lantern Fest provided an overview of their best practices during the March 2017 ARC meeting. They prefer to hold operations in rural areas, and away from urban areas and airports to ensure safety and easier post-operation cleanup. In cases where the site selected is near an airport, Lantern Fest currently coordinates with airport directly before the proposed operations. FAA does not currently regulate sky lanterns and, as such, there are no guidelines on coordination and notification procedures when operating near an airport, which was noted as a challenge by Lantern Fest.

Sky lantern manufacturers also offer user guidelines for safety best practices. For example, Sky Lanterns.us outlines several best practices and safety measures for operating lanterns [10]. These include:

- Avoiding operations in windy conditions to prevent collapse of lanterns and associated fire hazards
- Avoiding operation in drought and dry conditions to prevent fire hazards
- Operating lanterns only in clear upward paths to avoid lanterns drifting into nearby buildings and obstacles
- Use of safety materials like, flame redundant treated paper to avoid lanterns catching on fire
- Launching at least 5 miles away from airports
- Launching away from roads and public thoroughfares
- Avoid launching of lanterns by children
- Avoiding handling of lanterns under influence of alcohol or drugs
- Having ready access to water and fire extinguishers for potential fire emergencies
- Avoiding use of torn and damaged lanterns

### 4.3.3. ARC Recommendations for Fireworks and Sky Lanterns

A key focus of ARC recommendations was bringing awareness to the potential hazards posed by fireworks and sky lanterns to aviation. Additionally, the ARC proposed recommendations to formalize current best practices on coordination and notification adopted by display fireworks and sky lantern events into appropriate regulatory requirements. Several ARC members noted that there can be a mentoring relationship between the well-established display fireworks community and the new and expanding sky lantern events community given that both types of operations involve fire safety considerations and routinely coordinate with local authorities on operating guidelines. Another ARC member noted that the FAA should consider sky lantern operations to be similar to UFB operations.

While these recommendations are developed using existing terminology on categories of fireworks, sky lanterns, and differentiating sky lantern events from individual use, the ARC expects that the FAA will refine this terminology appropriately as needed when they further assess these recommendations. This section documents priority and rulemaking recommendations for fireworks and sky lanterns in response to Charter questions.

*Priority Recommendations*

The ARC developed priority recommendations to ensure that the FAA can better leverage current best practices and voluntary notification measures employed by display fireworks and sky lantern event operators to promote safe operations.

- Regulations: The FAA should develop a methodology for accountability for the use of consumer fireworks and sky lanterns by the non-professional user, which may include altitude or airport proximity restrictions.

Several members of the ARC expressed concern about the use of consumer fireworks and sky lanterns by non-professional users and hobbyists, especially near airports. The ARC recognized that regulating non-professional use of fireworks and sky lanterns poses a significant challenge given the scale of operations and the issues associated with enforcing regulations. Some members also noted that consumer fireworks and sky lanterns may be currently regulated by the local authority having jurisdiction, however, regulations tend to vary by state. Furthermore, local law enforcement agencies are typically responsible for enforcing regulations on consumer fireworks and sky lanterns.

The ARC discussed several options for how the FAA may place restrictions on consumer fireworks and sky lanterns including prohibiting operations in the vicinity of airports, restrictions based on class of airspace, and altitude restrictions. However, the ARC did not come to an agreement on the specific parameters of potential operational limitations.

- General Recommendations: The FAA should develop a PSA for large, routine events such as Fourth of July or New Year's Eve for fireworks and sky lanterns in cooperation with display fireworks and sky lantern event operators.

PSAs are commonly used today to inform the general public of the safety considerations associated with the use of fireworks. A PSA developed jointly by the FAA and operators could help educate the public on the safe use of fireworks and sky lanterns from an aviation perspective.

- General Recommendations: The FAA should develop advisory circulars (AC) for fireworks and for sky lanterns, similar to AC 91-57A for model aircraft.

In January 2016, the FAA issued AC 91-57A - Model Aircraft Operating Standards to provide guidance to persons operating unmanned aircraft for hobby or recreation purposes meeting the statutory definition of "model aircraft" contained in Section 336 of Public Law 112-95, the FAA Modernization and Reform Act of 2012. The guidance describes means by which model aircraft may be operated safely in the NAS [11].

- Notice Requirements and Authorizations: The FAA should work in collaboration with NATCA to standardize and formalize internal FAA reporting procedures for display fireworks and sky lantern events with consistent points of contact throughout the NAS.

This recommendation is intended to ensure that voluntary notification information currently provided by display fireworks and sky lantern event operators is made accessible to relevant FAA personnel and to other NAS users in a timely manner. During ARC discussions, the FAA noted that currently there are no internal procedures for processing voluntary notification information on display fireworks. For instance, such internal procedures could involve a review proposed of operations, appropriate impact analysis, identification of mitigations if needed, and issuance of a NOTAM by appropriate FAA personnel. The ARC agreed that the FAA should communicate its decision back to the proponents to address the concern that previously

proponents did not consistently receive feedback from the FAA. Some members commented that the notifications should be handled through a centralized office.

- Notice Requirements and Authorizations: The FAA should provide operators access to appropriate means for notifying NAS users of planned display fireworks and sky lantern events.

This recommendation is aimed at ensuring that notification regarding planned display fireworks and sky lantern events is disseminated to NAS users in a timely manner. Currently, NAS users can be informed of planned events through NOTAMs. As indicated during ARC meetings, there are no requirements around filing NOTAMs based on voluntary notification by display firework or sky lantern event operators and the practice of issuing NOTAMs is not consistently followed. The ARC recommended that the FAA should provide operators access to the NOTAM system as that is the current notification system, via the NOTAM Manager or through flight service stations to notify NAS users of planned display fireworks and sky lantern events. The ARC also noted that in the future, the FAA may enable this recommendation based on an alternative means for notification if needed.

*Rulemaking Recommendations*

The ARC developed rulemaking recommendations to codify current best practices and voluntary notification measures employed by display fireworks and sky lantern event operators through regulatory requirements under 14 CFR Part 101.

- Regulations: The FAA should add the terms “fireworks” and “sky lanterns” to Part 101 General Section, 14 CFR §101.1, 14 CFR §101.5, and 14 CFR §101.7.

This recommendation explicitly recognizes the potential risk posed by all categories of fireworks and sky lanterns to aviation activity. By including fireworks and sky lanterns in Part 101 General Section, 14 CFR §101.1, 14 CFR §101.5, and 14 CFR §101.7, the FAA will provide guidelines on fireworks and sky lanterns related to applicability of 14 CFR Part 101, operations in prohibited or restricted areas, and hazardous operations respectively. The ARC did not expect any notable impacts from this new proposed rule. Benefits identified included well-defined guidelines for fireworks and sky lantern operations to address potential safety risk posed to aviation.

- Notice Requirements and Authorizations: The FAA should add two new Sections to Part 101 called “Display Fireworks” and “Sky Lantern Events,” with the requirement that display fireworks and sky lantern event organizers must notify the FAA and NAS users of planned events a specified number of days in advance, via an appropriate means for notification, respectively. The number of days required for advanced notice will be determined by the FAA.

The ARC recommended that the FAA formalize the voluntary notification practices currently employed by operators of display fireworks and sky lantern events by implementing a new regulatory requirement on notification of planned events. This notification can take place through the NOTAM system as that is the current notification system, however, in the future an alternative means can be utilized if needed. While the ARC recommended the terms “Display

Fireworks" and "Sky Lantern Events", it was also recognized that the FAA rulemaking team should reassess this terminology and make refinements as necessary.

The ARC did not come to consensus on how far in advance the notification of planned events should be made to the FAA and to NAS users. The APA provided an example of a notional notification timeframe where event organizers notify the FAA of planned events 30 days in advance and NAS users seven days in advance via appropriate means with some exceptions such as rain dates and cancellations.

Some ARC members expressed concerns about FAA authority to deny operations with a notification rule. There was agreement across all the ARC members that the FAA should retain the ability to evaluate proposed operations and deny any operations that are deemed unsafe. It was noted that a notification requirement for display fireworks and sky lantern event operators and standardized FAA procedures on handling notification information will enable the FAA to identify and take appropriate action on proposed events that present unacceptable risk to airspace users.

Preliminary impacts of this recommendation were identified by the ARC as potential minor cost increases for operators given that display fireworks and sky lantern event operators currently voluntarily notify the FAA about proposed operations. However, they have no access to a notification system to advise NAS users. The ARC also discussed preliminary benefits resulting from this recommendation. A requirement on consistent notification of planned events would enable baseline data collection for ongoing safety analysis. Also, standardized and timely notification will increase situational awareness for all NAS users. Finally, standardized procedures would potentially reduce coordination confusion with FAA and allow for relationship development between the FAA and fireworks and sky lantern industry.

## 4.4. Hybrids

Hybrid operations are not a formally defined operation recognized by the FAA. Generally, hybrid operations combine performance characteristics from two or more systems or devices; e.g., unmanned free balloon releasing a glider; or unmanned free balloon serving as the airborne platform for an amateur rocket launch. In recent years, there has been a surge of interest in using high altitude UFBs as airborne launch platforms, due to their relatively low-cost structure, and increased reliability. Proposals include using UFBs to launch other aircraft/devices like rockets, gliders, and UAS.

*Priority Recommendations*

- The FAA should regulate hybrids by phase of flight and follow the regulations for the varied vehicle type, and/or permit operations on a case-by-case basis.

The operational and regulatory context for hybrids is rapidly changing. Due to the varied performance characteristics of hybrids and the safety implications, each phase of operation should follow the regulations associated with the primary operating equipment. For example, as a rocket attached to a balloon launch platform is ascending, it would fall under 14 CFR Part 101, Subpart D. Once it reaches its second phase, an amateur rocket launch would fall under 14 CFR

Part 101 Subpart C. If a UFB is the launch platform for a UAS, then the second phase would fall under 14 CFR Part 107.

# 5. References


[1] Federal Aviation Administration, *Part 101 Aviation Rulemaking Committee,* U.S. Department of Transportation, 2016.

[2] U.S. Government, *U.S. Code Title 5, Administrative Procedures, Section 553 - Rule making,* 1966.

[3] International Civil Aviation Organization, "Annex 2, Rules of the Air, 10th Ed.," 2005.

[4] U.S. Government, *Code of Federal Regulations Title 27, Commerce in Explosives Part 555,* 1981.

[5] U.S. Consumer Product Safety Commission, *Fireworks Business Guidance,* 2017.

[6] The American Pyrotechnics Association, "Fireworks-Related Injury Rates Continue to Decline as States Liberalize Laws," 2017. [Online]. Available: www.americanpyro.com/assets/docs/FactsandFigures/2consumpvinjuriesliberalizationgraph%201976-2016.pdf.

[7] International Code Council, Inc., "2015 International Fire Code," May 2014.

[8] B. Gabbert, "Update on the Legality of Sky Lanterns - Banned in 29 States," 2015. [Online]. Available: wildfiretoday.com/2015/12/31/update-on-the-legality-of-sky-lanterns-banned-in-28-states/.

[9] "U.S. News and World Report," [Online]. Available: www.usnews.com/news/best-states/alaska/articles/2017-06-02/alaska-events-change-focus-as-sky-lantern-ban-begins.

[10] "SkyLanterns.US," 2017. [Online]. Available: www.skylanterns.us/v/vspfiles/assets/SkyLanternSafetyUsage/SkyLanternProductInsert.pdf.

[11] Federal Aviation Administration, *Advisory Circular 91-57A - Model Aircraft Operating Standards,* 2016.

# A. Presentations to the ARC

**Table 6. List of Presentations to ARC**

| Date | Presenter | Title |
|---|---|---|
| **Introductory Briefings** | | |
| January 2017 | MITRE | 14 CFR Part 101 ARC Meeting Welcome and Introductions |
| January 2017 | FAA Office of Rulemaking (ARM-100) | Introduction to the ARC |
| January 2017 | FAA ATO, Airspace Services (AJV-115) | Current Part 101 Regulations |
| January 2017 | MITRE | SRM Process to Support New Entrant Rule Making |
| January 2017 | MITRE | Meeting Outcomes and Rules |
| **Safety Briefings** | | |
| January 2017 | MITRE | Safety Assessment Work Related to Part 101 Regulations |
| January & May 2017 | FAA ATO Safety Management Group (AJI-31) | FAA Air Traffic Organization of Safety and Technical Training, New Entrants Preliminary Safety Analysis |
| January 2017 | FAA Office of Commercial Space Transportation (AST) | Overview of Aircraft Vulnerability Models (AVMs) Used for Launch Safety |
| January 2017 | FAA AST | Aircraft Vulnerability to Space Vehicle Debris Impacts and Risk from Free Balloons |
| January 2017 | MITRE | Arizona State Football Fireworks |
| January 2017 | MITRE | New Entrant Safety Data Analysis |
| January 2017 | MITRE | Historical Data Analysis in support of the Preliminary Safety Assessment Hazards and Risks associated with UFBs and Hybrids |
| February 2017 | FAA AST | Aircraft Vulnerability and Collision Risk Models Applied to Balloon Payloads |
| March 2017 | MITRE | Analysis of Mandatory Occurrence Reports UFBs and Fireworks |
| March 2017 | MITRE | Risk Analysis of Mandatory Occurrence Reports involving Part 101 Participants in the NAS |
| May 2017 | MITRE | Quantifying Safety Risk to Aircraft from Small Unmanned Free Balloons and Other Airspace Vehicles |
| May 2017 | FAA ATO, Airspace Services (AJV-115) | Fireworks and Sky Lanterns |
| May 2017 | MITRE | Part 101 Report Outline |
| May 2017 | MITRE | Unmanned Free Balloon To-Be Scenario - VFR Departing out of Class C Airspace with VFR Flight Plan |
| July 2017 | FAA U.S. NOTAM Governance (AJR- | U.S. NOTAMS |
| **Industry Briefings** | | |
| January 2017 | World View Enterprises | Intro to Operations |
| January 2017 | NASA | NASA's Scientific Balloon Program - A Brief Introduction and Fiscal Year 2017 Flight Manifest |
| January 2017 | NOAA | Briefing on NOAA Upper Air Program |
| January 2017 | APA | Briefing on Operations |
| January 2017 | Google X, Inc. | Briefing on Project Loon |
| January 2017 | Montana State University | BOREALIS Montana Space Grant Consortium's High Altitude Balloon Program |
| January 2017 | Lantern Fest | Briefing on Sky Lantern Operations |
| **Other Briefings** | | |
| March 2017 | MITRE | Part 101 Voluntary Industry Questionnaire - Preliminary Findings |
| March 2017 | MITRE | Pilot Certification Requirements for Small Unmanned Aircraft Systems |
| May 2017 | FAA Office of Rulemaking (ARM-100?) | FAA Rulemaking and Executive Order |
| May 2017 | MITRE | Part 101 Industry Questionnaire Findings |
| July 2017 | MITRE/Graham Aerospace | Part 101 Draft Recommendations Update |
| July 2017 | MITRE | Pilot Certification Requirements for Small Unmanned Aircraft Systems |

# B. Abbreviations and Acronyms

| Acronym | Definition |
|---|---|
| **AC** | Advisory Circular |
| **ADS-B** | Automatic Dependent Surveillance - Broadcast |
| **AJI** | FAA Office of Safety and Technical Training |
| **AJV** | FAA Airspace Services |
| **APA** | American Pyrotechnics Association |
| **APO** | FAA Office of Aviation Policy and Plans |
| **ARC** | Aviation Rulemaking Committee |
| **ATC** | Air Traffic Control |
| **ATF** | Bureau of Alcohol, Tobacco, Firearms, and Explosives |
| **ATO** | Air Traffic Organization |
| **CEDAR** | Comprehensive Electronic Data Analysis and Reporting |
| **CFR** | Code of Federal Regulations |
| **FAA** | Federal Aviation Administration |
| **AST** | FAA Office of Commercial Space Transportation |
| **ft** | feet |
| **ICAO** | International Civil Aviation Organization |
| **IMC** | Instrument Meteorological Conditions |
| **lbs.** | Pounds |
| **MITRE** | The MITRE Corporation |
| **MOR** | Mandatory Occurrence Report |
| **NAS** | National Airspace System |
| **NASA** | National Aeronautics and Space Administration |
| **NATCA** | National Air Traffic Controllers Association |
| **NFPA** | National Fire Protection Association |
| **NOTAM** | Notice to Airmen |
| **NWS** | National Weather Service |
| **PSA** | Public Service Announcement |

| | |
|---|---|
| **R&D** | Research and Development |
| **sUAS** | small Unmanned Aircraft System |
| **TCAS** | Traffic Alert and Collision Avoidance Systems |
| **U.S.** | United States |
| **UAS** | Unmanned Aircraft System |
| **UFB** | Unmanned Free Balloon |