Unforeseen Consequences from the Sea: Impacts on the Space Launch Industry due to the Lack of Maritime Policy

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Author Biography

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Abstract

The rocket launch industry has been growing exponentially in the last two decades with commercial and federal launch contractors working side by side to accomplish incredible feats. With this increased number of successful launches also comes an increased number of scrubbed launches. These scrubs, more than ever before, are no longer solely due to weather. Maritime activity has affected rocket launches before, but never at the rate that we see today. This is a complex issue that relies on FAA policy law, industry experts, professionals in space law, and US code to properly deconstruct and understand. Over the last year, this team has been dedicated to understanding this issue by researching FAA policy, US code, and interviewing industry professionals to better understand why and how waterborne vessels have and can scrub rocket launches, and to offer recommendations as to how industry professionals could solve this problem.

Contents

Introduction

When one thinks of why rocket launches are delayed, the first thing that comes to mind is probably not "fishing boats." There are many causes that lead to scrubbing rocket launches, the most common being weather and technical issues. The Federal Aviation Administration (FAA) has established safety protocols for air traffic, ensuring flight paths of commercial and private aircraft do not intersect with predetermined hazard areas, established if a rocket experiences an anomaly. In addition to these established no-fly zones, ranges also created maritime hazard areas for persons on waterborne vessels. Originally, FAA 14 Parts 415, 417, 431, and 435 were the key pieces of United States code that determined the guidelines associated with establishing these hazard areas. Recently, however, these parts have been consolidated into FAA 14 Part 450, which introduced error thresholds specifically for maritime vessels and persons onboard said vessels for the first time.

Launch activity across the United States has exponentially increased since the Commercial Space Launch Act of 1984, which allowed commercial space companies to develop launch vehicles for the first time in United States history. While it took a considerable amount of time for commercial companies to develop the technologies necessary for space flight, today commercial space is one of the most lucrative businesses with an estimated value of $158 billion as of 2016, and global launch activities estimated at a value of $414.8 billion as of 2018. (Highfill, 2019) The commercial space industry is growing, with an estimated future revenue generated of $1 trillion by 2040. (Morgan Stanley, 2020) With this rapid growth, rocket launches are occurring more frequently than ever before. This increased launch activity puts stresses on the existing launch and safety infrastructure which has resulted in more incursions by maritime vessels than ever before.

What was once a happenstance, is now a serious logistic and economic issue for launch ranges and launch contractors across the United States.

Methods

The goal of this research effort was to better understand 1. How agreements between private and government launch contractors and contractors of launch infrastructure work together within the guidelines of FAA Policy to successfully complete launch goals, 2. How maritime policy (or lack thereof) affect launch contractors logistically and economically, and 3. What implications these economic and logistic affects have for the launch industry as a whole.

This research consisted of two primary elements. The first element was researching and understanding FAA policy. This primarily consisted of reading FAA Policy, more specifically, FAA 14 Part 415, 417, 431, 435, and the newly presented Part 450. These policies deal with launch and re-entry launch requirements and licenses for space launch and re-entry vehicles. The second element was reaching out to industry professionals in the FAA and at spaceports across the country to understand each spaceports specific experiences and issues with maritime vessels. The goal was to determine what specific issues spaceports and launch ranges have had in the past with maritime vessels incurring hazard areas and how spaceports addressed the issue. Information gathered from industry professionals was cross referenced to adequately compare and contrast how spaceports of different kinds (i.e. government owned vs privately owned) have dealt with this issue.

Industry professionals were interviewed at the Pacific Spaceport Complex (PSC) in Kodiak Alaska (formerly known as the Kodiak Launch Complex), the Mid-Atlantic Regional Spaceport (MARS) at Wallop’s Island, Virginia, and the Cape Canaveral Spaceport at Cape Canaveral, Florida. Each of these spaceports offers a unique perspective on maritime issues as each spaceport differs in geography, culture, and major economic industries of their respective areas.

Current FAA Regulations

As of October, 2020, the FAA had significant policy changes to the portions of the regulations that include commercial launch and re-entry vehicles. Originally, these parts were separated in FAA 14 Parts 415, 417, 431, and 435. Each part referenced specific legal and contractual agreements that launch contractors are responsible for in their launch and re-entry vehicles.

Merging of FAA 14 Parts 415, 417, 431, and 435

FAA 14 Part 415 described the proper way to acquire a valid launch license as a launch contractor attempting to launch from a federal or commercial launch site. This was strictly for expendable launch vehicles. Part 415 also detailed what regulations a launch contractor must comply to in order to maintain their launch license. FAA 14 Part 417 outlined the launch safety protocol that launch contractors must abide by for expendable launch vehicles. This included launch, flight, and ground safety. Section 417.223 (a) (4) specifically mentions that the launch contractor is responsible to conduct a flight safety analysis including waterborne vessels that may be affected by an anomaly during flight, but it does not specify by which error margin this must be quantified.

FAA 14 Part 431 described the requirements for launch contractors to obtain a reusable launch vehicle (RLV) mission license as well as the requirements involved in maintaining this license. This refers to FAA 14 Part 415 for the regulations required for expendable launch vehicles as the same regulations for RLVs. FAA 14 Part 435 outlines the requirements for obtaining licenses for re-entry vehicles other than RLVs along with what is required of launch contractors to maintain those licenses. This includes policy review, safety review and approval for re-entry of a re-entry vehicle, payload review (requirements for human and non-human payloads), and post-licensing requirements for launch contractors.

FAA 14 Part 450

FAA 14 Part 450 merges the previous Parts 415, 417, 431, and 435 and expands on key areas. The most pertinent was the addition of specific error calculations for maritime vessels and persons onboard maritime vessels in proximity to launch activity. This is outlined in detail in Part 450.133 (b), which states hazard areas that are capable of containing debris resulting from normal and abnormal flight events is required to contain, with up to 97% certainty, any debris resulting from normal flight events that is capable of causing casualty to persons on waterborne vessels. Part 450.133(b) expands on this by also including the specific error calculation that the probability of debris causing casualty on waterborne vessels must not exceed $1x10^{-5}$. (FAA, 2021)

FAA 14 Part 450.133(3) contains additional application requirements for launch contractors seeking a launch license that pertain to the risk of persons specifically onboard waterborne vessels. These requirements include a description of the methodology used by the launch contractor to determine the hazard area including the various classes of waterborne vessels and the vulnerability criteria for each. While this was required in FAA 14 Part 417 for aircraft, this waterborne vessel classification is a new addition to Part 450. Launch contractors are also required to submit tabular data and graphs of their results of their flight hazard area analysis which must include the following: 1. Geographical coordinates of the hazard area, 2. Representative 97% probability of containment contours for all debris resulting from normal flight events that are capable of causality for all locations specified, 3. Representative individual probability of casualty contours for all locations identified, with tabular data and graphs showing the hypothetical location of any member of the public that could be exposed to a probability of casualty of $1x10^{-5}$ or greater for neighboring personnel, and $1x10^{-6}$ or greater for other member of the public, 4. Representative $1x10^{-5}$ and $1x10^{-6}$ probability of impact contours for all debris capable of causing a casualty to persons on a waterborne vessel regardless of location, and 5. Representative $1x10^{-6}$ and $1x10^{-7}$ probability of impact contours for all debris capable of causing a casualty to persons on aircraft regardless of location. (FAA, 2021)

Results

The consolidation of the previous FAA regulations into FAA Part 450 allowed the simplification and addition of several key points for the safety of persons on waterborne vessels. This results in, as of December, 2020, over 370 licensed launches, 22 licensed reentries, 12 spaceport operator licenses, 46 permitted experimental launches, 7 active safety approvals, and 24 active launch licenses. (FAA, 2021, Part 450) The research conducted on the FAA regulations revealed a few key gaps in policy that FAA 14 Part 450 attempted to remedy. The first being that prior to Part 450 there was no mention of a specific error calculation or boundary for persons on waterborne vessels during a rocket launch. These probability of casualty calculations are present in Part 417, but Part 450 adds the probability calculation specifically for persons on waterborne vessels regardless of location. While on paper these added measures would seem to make significant changes in informing mariners of rocket launch activities, the next, and more important part of this problem is perspective. Each spaceport operates differently, in different areas of the country, with different issues at play as to why waterborne vessels violate these safety zones and delay and scrub launches. The best way to analyze this was to interview industry professionals for their respective launch ranges and spaceports and cross reference the information obtained.

Interviews with Industry Professionals

Three launch ranges most affected by waterborne vessels are Cape Canaveral Spaceport located in Cape Canaveral, Florida, PSC located in Kodiak, Alaska, and MARS located in Wallops Island, Virginia. To investigate further, the team met with the heads of spaceport operations at each spaceport, Pat McCarthy, the director of spaceport operations at Kennedy Space Center, Mark Lester, the CEO of the Alaska Aerospace Corporation at the PSC, and Douglas Voss, the NASA Deputy Chief at the Range and Mission Management Office at Wallops Flight Facility.

Spaceports Economics

Cape Canaveral is an incredibly popular place for competitive fishing tournaments, weekend boaters, international and domestic fishing, and what is most notably known for since the late 1950s, rocket launches. With Florida's natural good weather, high population of outdoors enthusiasts, and 3,341 miles of coastline on the Atlantic alone, Florida is one of the most popular locations for recreational and professional fisheries in the country. (NOAA, 2021) That combined with Port Canaveral, one of the busiest international shipping ports in the country, and Cape Canaveral being one of the busiest areas for launch activity in the United States. Cape Canaveral is seeing the highest density in launch activity since NASA's Apollo era in the 1960s and 70s. The team interviewed Pat McCarthy, the director of operations at Kennedy's Space Center, for his insight on this issue, the Coast Guard's involvement, and the economics of what postponed launches mean for launch contractors.

As Cape Canaveral Spaceport is capable of launching some of the largest rockets in the world, it is also more expensive than smaller launch ranges in the United States. At Cape Canaveral, apart from the infrastructure costs of launch like fuel and oxidizer storage, tower maintenance, etc., is the number of personnel required to successfully launch a rocket. It is estimated that there are approximately 300-400 personnel involved in a single launch, including emergency medical services, range services, weather services, coast guard personnel, FAA personnel, and security services. (McCarthy, 2020) If a launch is delayed for any circumstances, these personnel will either have to stay and be paid overtime or return when the launch is rescheduled. All of this costs the launch contractor money, and while these personnel are all required at all launch ranges in the United States, it is particularly expensive at Cape Canaveral due to the overwhelming number of personnel. While the exact amount of money a postponement causes a launch contractor is difficult to nail down, as each launch is different, with different mission criteria and infrastructure, it is estimated to cost millions of dollars per postponement. (McCarthy, 2020)

The PSC is unique as it is one of the only spaceports in the United States that is a commercially run spaceport. This spaceport, located in Kodiak, Alaska, is one of the leading economic industries of the area, and does not operate on any state or federal funds. All funds to run the spaceport are provided by the customers the spaceport serves. The PSC has a similar problem to Cape Canaveral Spaceport, as the surrounding waters of Kodiak are some of the busiest for commercial fishing and international shipping in the United States. In addition, the PSC has to deal with the fact that is geographically remote. In the past, the range had to fly up launch personnel from the lower 48 states to conduct every launch, but now, the team has shifted to only hiring Alaska natives to cut down on costs and improve launch efficiency. For example, if a lunch is postponed, depending on the length of the delay, the launch personnel would either have to stay in the Alaska area, of which the range would have to financially support, or the launch personnel would have to be flown back to the lower 48 and then be flown back to Kodiak to attempt launch again. The costs associated with this, especially for a smaller, completely economically self-sufficient spaceport, can inhibit their ability and efficiency as a spaceport.

MARS in Wallops Island, Virginia faces similar issues as the PSC and Cape Canaveral Spaceport in that the spaceport is located in an extremely busy portion of maritime space in the mid-Atlantic. MARS is located on the peninsula of the Chesapeake Bay, one of the busiest waterways in the United States for international shipping and trading, as it leads to the most inland harbor in the country, the Baltimore Harbor. In addition, MARS is located just north of Chincoteague Island, which is a national park with some of the most competitive fishing environments in the country. The area's economy is largely dependent on the fishing ecosystem of the area and MARS often has to work with the people and businesses of the area to ensure launches don't encroach on these industries and vice versa.

Fishing is so important in PSC and MARS that Mark Lester and Douglass Voss both meet with local industries that economically depend on the fishing in the area and heads of shipping and trade that use those waterways to ensure that launch activity does not encroach on these activities. Rocket launches in both of these locations do not take precedent to these events like they do at Cape Canaveral. These launch complexes are heavily dependent on support from local communities and state governments to be successful, so if these spaceports were to disregard these factors, they would lose the areas economic and political support.

The United States Coast Guard's Role

It is the responsibility of the launch contractor and the spaceport to notify the United States Coast Guard (USCG) thirty days before the intended launch date. This notification includes a hazard area map for waterborne vessels as described in FAA 14 Part 450.133(3), explained above. During the countdown, it is the Coast Guard's responsibility to monitor the area, with the help of weather and radar surveillance, to ensure the predesignated hazard area remains clear. If a waterborne vessel were to enter the hazard area, and the waterborne vessel will not exit the hazard area with its current trajectory and velocity in time for launch, the countdown will be put on a hold. If it is determined that the vessel will not exit the hazard area within the designed launch window, the launch will be scrubbed until a new launch window is determined.

If there is enough time to act, the USCG can intercept the waterborne vessel and direct it to exit the hazard area immediately. The USCG have the ability to issue persons on a waterborne vessels violating the hazard area a $1,000 fine. (Lester, 2020) The USCG only has jurisdiction to twelve miles off the coast of the United States, and therefore can not impose any restrictions or rules on waterborne vessels in international waters. Hazard areas extend far into international waters, as they follow the trajectory of the launch vehicle until it is at a high enough altitude that it would no longer affect that area.

Discussion

There are some important caveats to investigate with the knowledge from this research. The first being to better understand the economic impacts of scrubbed launches for launch contractors. As explained before, scrubbing a launch is expensive, taking into account personnel, fuel, and infrastructure for rent. The launch contractor is entirely responsible for these costs. Something the team investigated was determining how reasonable or possible it would be for a launch contractor to sue a waterborne vessel if a launch was proven to be scrubbed by the actions of persons onboard of this vessel. While at first this seems like an appropriate reaction to the launch contractor losing hundreds of thousands, sometimes millions of dollars, it quickly falls apart when you apply this argument to the personal watercraft level. If a large international shipping company violated the water hazard area, for example, it would be sensible for the launch contractor to pursue legal action, but if a private boater happens to violate the hazard area, there is no economic point for a launch contractor to pursue legal action as the person responsible will not have the means to pay the launch contractor for their economic losses.

The second key point to recognize is the USCG's means of enforcement. Within US boarders, the USCG has the ability to issue a $1,000 fine to boaters that violate the hazard area. While this is technically possible, there has not been an instant to date where the USCG has followed through with this enforcement, despite the increase in recent years of waterborne vessel violating hazard areas and being solely responsible for scrubbed launches. Mark Lester was able to shine some light as to why this is. He noted that while the USCG has the authority to fine, they often don't want to. Their main purpose is to protect the people that serve the vital fishing industry of the area (in this case Alaska). They don't want to be police officers, enforcing fines against the same people that they strive to keep safe. Tight knit communities in these areas drive local and state economies and interfering with that is wildly unpopular. In these communities, the rocket launch business, while bringing money to the area, is not the most important industry present.

The third key point to recognize is the lack of communication infrastructure between the launch contractor and the general population. While there are notices to mariners published every week in every region of the United States, there also seems to be little attempt to communicate with mariners outside of this. This can lead to confusion among mariners as to what is permissible and what is not permissible. The effects of this lack of communication was seen with the splash down of Crew Demo 1 in the Gulf of Mexico. Boaters gathered to watch a Space X capsule with astronaut's onboard splash down while there was no communication between the USCG present and the boaters nearby. When one boat began to head toward the capsule, and no action taken by the USCG present, all of the other boaters began to also head toward the capsule to get a better look, as they thought they weren't doing anything wrong. No boaters had ill intent to disrupt the recovery or harm the astronauts, their curiosity just got the best of them. This led to outrage in the aerospace industry as people wondered how such an incursion could have happened, and what implications this could have in the future if there was ill intent. The situation could quickly divulged into a national security risk very quickly. Communication between launch contractors and the other support personnel and infrastructure must improve to prevent boaters infiltrating launch hazard areas from happening again.

Conclusion

Today's space launch environment is constantly changing. New technologies have propelled the industry into a new era, with more launches occurring from spaceports worldwide than ever before. However, with this drastic increase in launch activity comes other challenges. Will launch infrastructure be able to keep up with this new norm? How will this effect industries that rely on unrestricted access to airways and waterways? How will civilian populations surrounding these busy spaceports be affected in the short and long term? In this report, the team attempted to tackle one of many issues that face this emerging industry. Maritime activity in all locations discussed range from casual fishing and water access to absolutely essential to the industries of these areas. The USCG must establish better protocol for communicating with local populations to inform them of the risks of surrounding spaceports. They also must establish better consequences to boaters that violate launch hazard areas. In particular, provide different consequences for recreational boaters as they would for large domestic and international shipping companies for violating launch hazard areas. While launch ranges currently strive to work with local industry to ensure a coexistence of both, more work must be done. As the team discovered via the interviews aforementioned, the heads of these ranges have a difficult balancing act to maintain. The FAA and USCG should work closer together during rocket launch preparation to alleviate pressure from the launch operations teams to ensure both entities remain unaffected. With rocket launch activity not slowing down anytime soon, the FAA, spaceports, USCG, and the U.S. government must work together to ensure the minimalization of the risks of spaceflight in the air, on the ground, and on the sea.

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