# Risk Assessment Mitigation Phase
# Risk Mitigation Plan
# Aviation Incident
# (SDG&E-8)

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# Executive Summary

Aviation Incident is the risk of an aviation event by SDG&E contractors, subcontractors or other third parties who may enter SDG&E's service territory that results in damages to electric transmission, distribution and/or gas transmission facilities. SDG&E's 2015 baseline controls include:

- Aviation Safety Management System (SMS) – comprehensive safety management approach consisting of policies and procedures applicable for aviation
- Job Site Observation Program – program that provides SDG&E aviation oversight of internal and contractor aviation construction operations
- Service Provider Audit Program – third party oversight program that provides an independent perspective regarding how to meet a standard of safety recognized through the aviation industry.
- "Best Practices" Training – training implementing best safety practices from throughout the aviation industry from a variety of sources.

These controls focus on safety-related impacts (i.e., Health, Safety, and Environment) per guidance provided by the Commission in Decision 16-08-018 as well as controls and mitigations that may address reliability. The 2015 baseline mitigations will continue to be performed in the proposed plan. In addition, SDG&E proposes to expand and add new mitigations to address the risk of Aviation Incident. The expanded and new mitigation activities are:

- Service Provider Audit Program – expand the program by requiring audits be performed before a contractor flies on company property for the first time and audit all contracted vendors on an annual basis.
- Purchase a Twin-engine Helicopter – helicopter enables a dual-redundant system where single-point failure exists; thereby cutting the frequency of an accident (if one were to occur) by half.
- Aviation Safety Training – the policy and procedure foundation consisting of an initial training manual for internal use of pilot development, continued training costs for currency and performance development, and case-by-case skills performance development.
- Currency and Proficiency Training with New Helicopter – a training that socializes the best procedural practices and promotes institutional knowledge and safety.

A risk spend efficiency was calculated for the Aviation Incident risk. The risk spend efficiency is a new tool that was developed to attempt to quantify how the proposed mitigations will incrementally reduce risk. For purposes of the risk spend efficiency, the proposed mitigations were grouped into two: Effective SMS Program (include training, on-site observation, and audits); and More Reliable Equipment. Based on a benefit-cost assessment (e.g. risk spend efficiency), the mitigations for this risk can be ranked as follows:

1. Effective SMS program
2. More reliable equipment

# Risk: Aviation Incident

## 1 Purpose

The purpose of this chapter is to present the mitigation plan of San Diego Gas & Electric Company (SDG&E or Company) for the risk of Aviation Incident. For the purposes of this filing, this risk is an aviation incident by SDG&E contractors, subcontractors or other third parties who may enter SDG&E's service territory that results in damages to electric transmission, distribution and/or gas transmission facilities. Additionally, Aviation Incident can be described as the combination of the Federal Aviation Administration's (FAA) definitions for *incident* and *accident*. For reference, an *aircraft accident* is an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person (either inside or outside the aircraft) suffers death or serious injury, or in which the aircraft receives substantial damage. An *aircraft incident,* by the FAA's definition, is an occurrence, other than any accident, that affects or could affect the safety of operations.[1] Direct and indirect damage is also accounted for in these evaluations of risk, as they directly impact the cost accountancy of accidents associated with any aviation incident.

This risk is a product of SDG&E's September 2015 annual risk registry assessment cycle. Any events that occurred after that time were not considered in determining the 2015 risk assessment, in preparation for this Report. Note that while 2015 is used a base year for mitigation planning, risk management has been occurring, successfully, for many years within the Company. SDG&E and Southern California Gas Company (SoCalGas) (collectively, the utilities) take compliance and managing risks seriously, as can be seen by the number of actions taken to mitigate each risk. This is the first time, however, that the utilities have presented a Risk Assessment Mitigation Phase (RAMP) Report, so it is important to consider the data presented in this plan in that context. The baseline mitigations are determined based on the relative expenditures during 2015; however, the utilities do not currently track expenditures in this way, so the baseline amounts are the best effort of each utility to benchmark both capital and operations and maintenance (O&M) costs during that year. The level of precision in process and outcomes is expected to evolve through work with the California Public Utilities Commission (Commission or CPUC) and other stakeholders over the next several General Rate Case (GRC) cycles.

The Commission has ordered that RAMP be focused on safety related risks and mitigating those risks.[2] In many risks, safety and reliability are inherently related and cannot be separated, and the mitigations reflect that fact. Compliance with laws and regulations is also inherently tied to safety and the utilities take those activities very seriously. In all cases, the 2015 baseline mitigations include activities and amounts necessary to comply with the laws in place at that time. Laws rapidly evolve, however, so the RAMP baseline has not taken into account any new laws that have been passed since September 2015. Some proposed mitigations, however, do take into account those new laws.

[1] 49 C.F.R. 830.2.
[2] Commission Decision (D.) 14-12-025 at p. 31.

The purpose of RAMP is not to request funding. Any funding requests will be made in the GRC. The forecasts for mitigation are not for funding purposes, but are rather to provide a range for the future GRC filing. This range will be refined with supporting testimony in the GRC. Although some risks have overlapping costs, the utilities have made efforts to identify those costs.

The risk assessment provided herein focuses on the drivers or hazards and potential resulting events for which SDG&E is aware,[3] and in which the leading regulatory and professional organizations that deal with flight are most concerned.[4] Hazards and events that are unknown to SDG&E are beyond the scope of this risk; however, SDG&E is making every effort to create a system by which new hazards can be identified quickly, moved upwards continuously, and evaluated through empowered employees and contractors such that new risks will be captured and evaluated pro-actively. Flying aircraft in support of SDG&E missions is within the scope of this risk.

## 2 Background

SDG&E's Aviation Services Department (ASD) supports electric transmission, electric distribution, and gas operations with manned and unmanned aircraft. Manned operations are primarily flown with rotary wing aircraft and include: scheduled powerline patrols, fault patrols, infrared camera patrols, vegetation management surveys, external load work, LiDAR[5] data collections, and aerial assessments. In addition, ASD provides an air-rescue capability to structures and areas that are accessible by helicopter only, and in close proximity to powerlines. Unmanned operations include pole-top and structure integrity assessments, environmental and sensitive area surveys, LiDAR data collection, and post storm or fire damage assessments.

## 3 Risk Information

As stated in the testimony of Jorge M. DaSilva in the Safety Model Assessment Proceeding (S-MAP) Application (A.) 15-05-002, "SDG&E is moving towards a more structured approach to classifying risks and mitigations through the development of its new risk taxonomy. The purpose of the risk taxonomy is to define a rational, logical and common framework that can be used to understand analyze and categorize risks."[6] The Enterprise Risk Management (ERM) process and lexicon that SDG&E has put in place was built on the internationally-accepted IS0 31000 risk management standard. In the application and evolution of this process, the Company is committed to increasing the use of quantification within

[3] SDG&E Aviation Services Department. SDG&E Draft Aircraft Operations Manual, Draft Version 1. June 2016.
[4] Federal Aviation Administration. Safety Management Systems: SMS Explained. June 5, 2016. https://www.faa.gov/about/initiatives/sms/explained/.
[5] LiDAR stands for Light Detection and Ranging. According to https://www.LiDARusa.com, it is "used to detect and measure the distance of an object or surface from an optical source."
[6] A.15-05-002, filed May 1, 2015, at p. JMD-7.

its evaluation and prioritization of risks.[7] This includes identifying leading indicators of risk. Sections 3 – 9 of this plan describe the key outputs of the ERM process and resultant risk mitigations.

In accordance with the ERM process, this section describes the risk classification, possible drivers and potential consequences of the Aviation Incident risk.

### *3.1 Risk Classification*

Consistent with the taxonomy presented by SDG&E and SoCalGas in A.15-05-002, SDG&E classifies this risk as an electric, operational risk as shown in Table 1.

**Table 1: Risk Classification per Taxonomy**

| Risk Type | Asset/Function Category | Asset/Function Type |
|---|---|---|
| OPERATIONAL | ELECTRIC/OTHER FACILITIES | Elect Transmission OH; Electric Distribution OH |

### *3.2 Potential Drivers*[8]

When performing the risk assessment for Aviation Incident, SDG&E identified potential indicators of risk, referred to as drivers. The term "drivers" is consistent with the risk lexicon approved by the California Public Utilities Commission in the S-MAP Decision (D.) 16-08-018. However, in accordance with industry best practices within the aviation industry, such "drivers" are referred to as hazards.[9] It should be recognized that SDG&E does not believe incidents or accidents are caused by a single failure, but often are the culmination of both active errors and latent conditions aligning to create an incident or accident.[10] This understanding is pervasive throughout many industries, and is considered an aviation industry best practice as established by such governing authorities as the international Civil Aviation Organization (ICAO), FAA, and academia.[11] Based on reviewing events in the industry, SDG&E identified the following drivers that could lead to an incident or accident.

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[7] Testimony of Diana Day, Risk Management and Policy (SDG&E-02), submitted on November 14, 2014 in A.14-11-003.
[8] An indication that a risk could occur. It does not reflect actual or threatened conditions.
[9] International Civil Aviation Organization. Doc. 9859 Safety Management Manual (SMM). 2013 http://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf
[10] Civil Aviation Safety Authority of Australia. SMS for Aviation—A Practical Guide. 2nd Edition. 2014 Pg14 https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/sms/download/2014-sms-book1-safety-management-system-basics.pdf.
[11] Reason, James. Managing the Risk of Organizational Accidents Ashgate Publishing, UK. 2013.

- **Active Errors** – An error can that occur due to someone not doing something correctly, in accordance with procedure or policies, even when the intent is to act in accordance with policy or procedure. The drivers that fall into this category are:
  - Pilot error or inexperience inclusive of intrusion into airspace
  - Inadequate pre-flight risk assessment
  - Field error or inexperience of ground crew
  - Loss of situational awareness, confusion (Controlled Flight into Terrain)

- **Latent Conditions** – A failure of programs/procedures intended to maintain safe flight or operation, yet creates conditions that lead directly to failure. Often these lead to non-regulation "workarounds" or "shortcuts" that can create unsafe environments, and in which active errors create incidents. The drivers that fall into this category are:
  - Inadequate visual markings or lighting of overhead transmission/distribution lines
  - Incorrect policy or procedure
  - Lack of oversight, complacency
  - Normalization of deviance that is uncorrected
  - Weather conditions that change rapidly

- **Hardware Failure** – A failure of the system from any elements in the aircraft that contributes to normal flight operations, such as material or avionics failure. The drivers that fall into this category are:
  - Aircraft or other equipment failure not related to maintenance
  - Maintenance failure leading to system failure
  - Malicious third-party software or signal
  - Incorrect automation inputs
  - On-board communications interference

Table 2 maps the specific drivers of Aviation Incident to SDG&E's risk taxonomy.

**Table 2: Operational Risk Drivers**

| Driver Category | Aviation Incident Driver(s) |
|---|---|
| **Asset Failure** | • Aircraft or other equipment failure not related to maintenance<br>• Maintenance failure leading to system failure |
| **Asset-Related Information Technology Failure** | • Incorrect automation inputs<br>• On-board communications interference |
| **Employee Incident** | • Pilot error or inexperience inclusive of intrusion into airspace<br>• Inadequate pre-flight risk assessment<br>• Field error or inexperience of ground crew<br>• Loss of situational awareness, confusion (Controlled Flight into Terrain)<br>• Inadequate visual markings or lighting of overhead transmission/distribution lines<br>• Incorrect policy or procedure<br>• Lack of oversight, complacency<br>• Normalization of deviance that is uncorrected |
| **Contractor Incident** | • Pilot error or inexperience inclusive of intrusion into airspace<br>• Inadequate pre-flight risk assessment<br>• Field error or inexperience of ground crew<br>• Incorrect policy or procedure<br>• Lack of oversight, complacency<br>• Normalization of deviance that is uncorrected |
| **Public Incident** | • Malicious third-party software or signal<br>• Pilot error/inexperience<br>• Disgruntled individual or terrorist attack<br>• Negative separation with aircraft<br>• Inadequate visual markings or lighting of overhead transmission/distribution lines |
| **Force of Nature** | • Weather conditions that change rapidly |

The abovementioned drivers capture the most probable causes of an aviation incident on SDG&E property or in support of SDG&E activities.

Failure rates in the aviation environment are fairly well known and, therefore.  Based on these aviation industry statistics applicable to this risk, SDG&E determined that risks associated with failures in communication, situational awareness and risk-assessment, which can all be categorized as pilot error, will continue to attribute to over 90% of all incidents or accidents.[12] By understanding that human error (pilot error) is the leading cause of a large majority of aviation accidents and incidents, the prime mitigation strategy should likewise address these failures. Likewise, while material failures (asset failure) are less prevalent than human error focused incidents, they still can occur and, therefore, must be acknowledged and assessed.

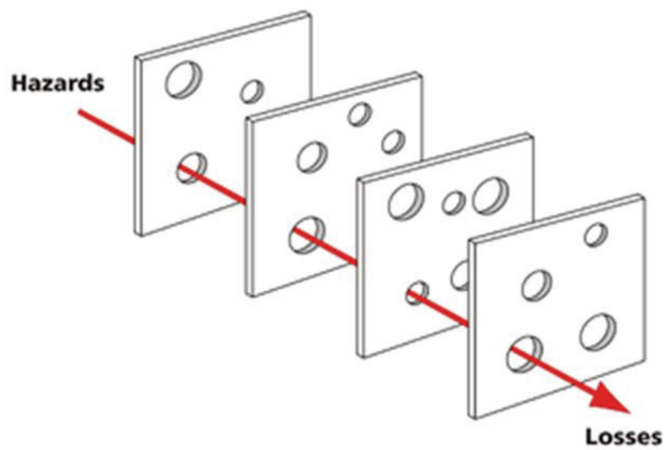
### *3.3 Potential Consequences*

The above drivers/hazards exist in all aviation oriented operations, and it is up to employees/contractors to develop proper mitigation strategies to eliminate incident or accident. The "Swiss-Cheese Model" of Aircraft Accident Causation illustrates that many layers of defense can be instituted to prevent these hazards from manifesting incidents or accidents. This model of accident causation and mitigation can be seen in Figure 1 below. The model, widely accepted as industry best practice in the aviation industry, is the foundation for a robust Safety Management System (SMS). It provides that while there are many layers of protection between potential drivers and accidents, there are flaws in each layer that, if aligned, can result in an incident. The overall system produces failures when a hole in each slice (a slice representing mitigation attempts such as policies, procedures, IT security, training, redundant systems, etc.) momentarily aligns, permitting an opportunity for a potential event to occur. When multiple layers of the mitigation fail, the incident or opportunity for accident can manifest an event.[13]

The goal of safety management is to identify these gaps in mitigations, before they culminate in the production of accidents – proactively through hazard (driver) identification, documentation, and education. Understanding that latent conditions often lead to active errors, it is important to create policies and procedures that evaluate and monitor all aspects of the operation for appropriateness. Monitoring incidents of pilot error and ensuring proper training is driven by these problems, helps fill these "holes" in the various mitigation layers, and therefore protects against catastrophic accidents.

[12] Hansen, Frederick. Human Error: A Concept Analysis. Journal of Air Transportation, at p 62. http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070022530.pdf.
13 Daryl Raymond Smith; David Frazier; L W Reithmaier & James C Miller (2001). Controlling Pilot Error. McGraw-Hill Professional. p. 10. ISBN 0071373187.

**Figure 1: Swiss-Cheese Model of Hazards and Losses**




Conversely, if proper mitigations are not in place to reduce the frequency of an event occurring, or the severity of the event is not diminished to a satisfactory result, then the following potential consequences, in a reasonable worst case scenario, could include:

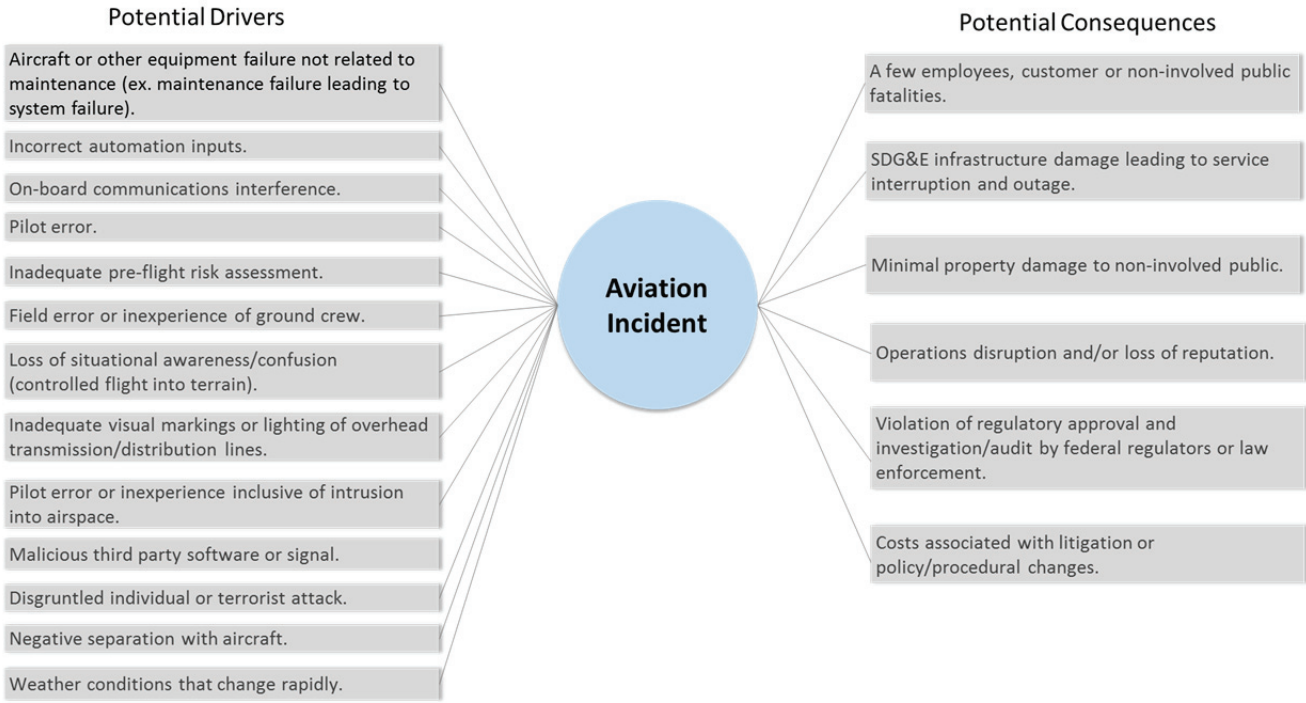
- A few employees, customer, or non-involved public fatalities.
- SDG&E infrastructure damage leading to service interruption and outage.
- Minimal property damage to non-involved public.
- Operations disruption and/or loss of reputation.
- Violation of regulatory approval and investigation/audit by federal regulators or law enforcement.
- Costs associated with litigation or policy/procedural changes.

These potential consequences were used in the scoring of Aviation Incident that occurred during the SDG&E's 2015 risk registry process. See Section 4 for more detail.

### *3.4 Risk Bow Tie*

The risk "bow tie," shown in Figure 2, is a commonly-used tool for risk analysis that shows the relationship between hazard conditions and the potential result if an event were to occur. The left side of the bow tie illustrates potential drivers/hazards that lead to a risk event and the right side shows the potential consequences of a risk event. SDG&E applied this framework to identify and summarize the information provided above.

**Figure 2: Risk Bow Tie**




# 4 Risk Score

The SDG&E and SoCalGas ERM organization facilitated the 2015 risk registry process, which resulted in the inclusion of Aviation Incident as one of the enterprise risks. During the development of the risk register, subject matter experts from SDG&E's Electric Distribution Operations department assigned a score to this risk, based on empirical data to the extent it is available and/or using their expertise, following the process outlined in this section.

The resulting risk score was calculated in the interest of providing acceptable knowledge of mitigation strategies prior to any Aviation Incident in accordance with the FAA Safety Management Manual (SMM), and the International Civil Aviation Organization (ICAO) Annex 19. This best approach for risk scoring is to analyze the severity of the potential outcome of a hazardous event, and the likelihood of that event occurring. This is calculated using both qualitative and quantitative methods, using subject matter expertise, industry rates of failures and accident causation, and studies conducted in support of aviation operations. There is an extensive amount of industry information for manned aviation and, therefore, encountering reliable quantitative methods for accident rates provides a pathway for reliable risk mitigation strategies. The risk score presented is based upon a worst case, but reasonable, scenario as identified as necessary by the FAA, ICAO, and other industry stakeholders to protect organizational interests.

### *4.1 Risk Scenario – Reasonable Worst Case*

There are many possible ways in which an aviation incident can occur. For purposes of scoring this risk, subject matter experts used a reasonable worst case scenario to assess the impact and frequency. The scenario represented a situation that could happen, within a reasonable timeframe, and lead to a relatively significant adverse outcome. These types of scenarios are sometimes referred to as low frequency, high consequence events. The subject matter experts selected a reasonable worst case scenario to develop a risk score for Aviation Incident:

- A Company-contracted helicopter experiences a mechanical failure inflight and enters out-of-control flight, leading to a crash with employee injuries or fatalities and a post-crash fire. This affects service to customers and results in litigation and financial impacts.

Note that the following narrative and scores are based on this scenario; they do not address all consequences that can happen if the risk occurs.

### *4.2 2015 Risk Assessment*

Using this scenario, subject matter experts then evaluated the frequency of occurrence and potential impact of the risk using SDG&E's 7X7 Risk Evaluation Framework (REF). The framework (also called a matrix) includes criteria to assess levels of impact ranging from Insignificant to Catastrophic and levels of frequency ranging from Remote to Common. The 7X7 framework includes one or more criteria to distinguish one level from another. The Commission adopted the REF as a valid method to assess risks for purposes of this RAMP.[14] Using the levels defined in the REF, the subject matter experts applied empirical data to the extent it is available and/or their expertise to determine a score for each of four residual impact areas and the frequency of occurrence of the risk.

Table 3 provides a summary of the Aviation Incident risk score in 2015. This risk has a score of 4 or above in the Health, Safety, and Environmental impact area and, therefore, was included in the RAMP. These are residual scores because they reflect the risk remaining after existing controls are in place. For additional information regarding the REF, please refer to the RAMP Risk Management Framework chapter within this Report.

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[14] D.16-08-018 Ordering Paragraph 9.

**Table 3: Risk Score**

| Residual Impact | | | | Residual Frequency | Residual Risk Score |
|---|---|---|---|---|---|
| Health, Safety, Environmental (40%) | Operational & Reliability (20%) | Regulatory, Legal, Compliance (20%) | Financial (20%) | | |
| 6 | 2 | 2 | 3 | 3 | 23,108 |

In addition to the risk assessment performed as part of the ERM risk registry process, a risk assessment was also conducted for the Aviation Incident risk in accordance with the ICAO Doc. 9859, industry best practices/FAA guidance, denoting appropriate severity and likelihood criteria for Aviation Incidents in order to compare the resulting risk scoring.[15] This alternative risk assessment produced comparable results to that of SDG&E's ERM risk evaluation; thereby validating the results of both. The results of the industry best practices/FAA guidance assessment determined that some of the baseline mitigations should be adapted. Largely this is due to the catastrophic nature of an accident leading to one or more fatalities. It should be recognized that the likelihood of the event selected in the risk scenario is extremely improbable; largely due to a fatal accident rate of .59 per 100,000 flight hours, and a representation in the utility industry of only 2.4%.

### *4.3 Explanation of Health, Safety, and Environmental Impact Score*

A score of 6 (severe) was given in the Health, Safety, and Environmental impact area. In determining this risk score, ASD evaluated the most likely outcome of a helicopter crash, based off industry and National Transportation and Safety Board (NTSB) data. In examining industry accident rates, it is noted that the environmental conditions, within which SDG&E will be most likely to operate, provide the most likely environments for helicopter accidents to occur. In a 2012 report by the FAA, recognized that 88% of all helicopter accidents occur in daylight conditions, and over 95% occur in Visual Meteorological Conditions (VMC). This makes the most sense as these conditions have the vast majority of flights taking place. Utility Patrols/Construction provided for 2.1% of all aircraft accidents between 2000 and 2006 (523 total accidents).[16] When looking at the likelihood of the event occurring, we can also see that there is an accident rate for the industry of roughly 3.64 helicopter accidents per 100,000 flight hours in 2014. With respect to the severity of these accidents, the rate dropped to a new industry low in 2014 as well, reaching .59 fatal accidents per 100,000 flight hours.[17] The most common reasons given for fatal

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[15] International Civil Aviation Organization. Safety Management Manual Document 9859 AN/474. ICAO 2013, at p. 2-28.

[16] Roskop, Lee. FAA. US Rotorcraft Accident Data and Statistics January 2012. PPT, at p. 13. https://www.aea.net/events/rotorcraft/files/US_Rotorcraft_Accident_Data_And_Statistics.pdf.

[17] Jackman, F. US Helicopter Accident Rates Down in 2014. Flight Safety Foundation. May 2015 http://flightsafety.org/aerosafety-world-magazine/may-2015/us-helicopter-accident-%E2%80%A8rates-down-in-2014.

accidents are "loss of control, obstacle and wire strikes, degraded visibility, system component failures and fuel issues." It should be noted that the close proximity to ground crews and "wires and obstacles" increases the likelihood of a fatal accident if any accident were to occur.[18]

Should a crash occur, likely fatalities will include pilot(s) and passengers, with the potential to affect personnel on the ground. This is especially true during construction operations, during which the helicopter is positioned in a hover above ground crews, often with external loads.

### *4.4 Explanation of Other Impact Scores*

Based on the selected reasonable worst case risk scenario, SDG&E gave the other residual impact areas each a score for the following reasons:

- **Operational and Reliability:** Aviation Incident was assigned a score of 2 (minor) as any service disruption to customers was determined using empirical data to the extent it is available and/or subject matter expertise to be minimal, affecting a small area or greater than 100 customers for a short period of time. An incident which would affect vital infrastructure, or customers directly, is mitigated by onboard pilot emergency procedures, standard operating limitation for proximity to distribution networks, and other items.
- **Regulatory, Legal, and Compliance:** SDG&E scored this risk a 2 (minor) due to the well-regulated and documented environment for manned aviation. Commercial manned aviation has had a long history of regulatory, legal, and compliance foundations and therefore procedures to align the program within these limitations are also well known. The responsibilities of an operator are well understood by SDG&E and training and policy protects the organization. While there is potential impact from litigation, regulatory and compliance elements would have little impact.
- **Financial:** A score of 3 (moderate) was given in this impact area. In accordance with SDG&E's 7X7 matrix, a 3 is defined as a financial impact ranging from $1 to $10 million. SDG&E subject matter experts determined this to be reasonable given the potential for litigation, as well as damage to private property or Company facilities, that could result from an aviation incident.

### *4.5 Explanation of Frequency Score*

Based off Company, industry and NTSB data, the frequency of an incident related to this risk is infrequent (Extremely Improbably) - once every 10-30 years. Accordingly, a score of 3 (infrequent) was given for the Aviation Incident risk. This is reflective of industry findings and accident rates, especially within the utility industry.

## 5 Baseline Risk Mitigation Plan[19]

As stated above, Aviation Incident risk entails an aviation-related event by SDG&E contractors, subcontractors or other third parties that may result in damages to electric and/or gas facilities. The 2015 baseline mitigations discussed below includes the current evolution of the utilities' risk

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[18] *Id.*
[19] As of 2015, which is the base year for purposes of this Report.

management of this risk. The baseline mitigations have been developed over many years to address this risk. They include the amount to comply with laws that were in effect at that time. The baseline controls include an aviation safety management system, a job site observation program, an audit program and "best practices" training. These controls focus on safety-related impacts[20] (i.e., Health, Safety, and Environment) per guidance provided by the Commission in D.16-08-018[21] as well as controls and mitigations that may address reliability.[22] Accordingly, the controls and mitigations described in Sections 5 and 6 address safety-related impacts primarily. Note that the controls and mitigations in the baseline and proposed plans are intended to address various aviation-related events, not just the scenario used for purposes of risk scoring.

### 1. Aviation Safety Management System

In 2015, SDG&E began implementing an aviation SMS - the leading mitigation currently in place. In essence, the SMS is the international leading, comprehensive safety management approach consisting of policies and procedures applicable for aviation. It is an absolutely critical system of management recognized as an industry best practice for minimizing aviation risk to the significant benefit and protection of SDG&E's employees, contractors, and the public at large. This mitigation stands on the four pillars outlined below as required by ICAO, FAA, and industry stakeholder certifications. It does this by establishing industry recognized best practices in risk management and safety focus from the top down. The public, contractors, and employees enjoy reduced risk benefits, increased access and communication to leadership, and continuous proactive safety program developments in a systematic and data driven manner. The additional baseline mitigations fall into one of the four categories below.

a. **Safety Policy** — Establishes senior management's commitment to continually improve safety; defines the methods, processes, and organizational structure needed to meet safety goals.
b. **Safety Risk Management (SRM)** — Determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk.
c. **Safety Assurance (SA)** — Evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards.
d. **Safety Promotion** — Includes training, communication, and other actions to create a positive safety culture within all levels of the workforce.

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[20] The Baseline and Proposed Risk Mitigation Plans may include mandated, compliance-driven mitigations.
[21] D.16-08-018 at p. 146 states "Overall, the utility should show how it will use its expertise and budget to improve its safety record" and the goal is to "make California safer by identifying the mitigations that can optimize safety."
[22] Reliability typically has an impact on safety. Accordingly, it is difficult to separate reliability and safety.

2. **Job Site Observation Program**

The job site observation program is a function of "Safety Assurance" and is associated with the SMS mitigation. It provides SDG&E aviation oversight of internal and contractor aviation construction operations. It provides direct oversight and "fact finding" to see how policies and procedures are being handled in a "live" environment. This position is staffed with an employee having both aviation and electrical line experience to maximize the effectiveness of the safety oversight.

3. **Service Provider Audit Program**

Auditing and third-party oversight and qualification is another portion of the Safety Assurance function within SMS, and is directly related to acquiring feedback and unbiased assessment of any aviation operation. The FAA and ICAO have all identified auditing and third-party inspection as a vital element of a healthy aviation organization. Audits require bringing in external companies for three to four days at a time to examine documentation of policies and procedures, data acquisition, and witness operations, both announced and unannounced. A third party audit program and oversight is a fundamental best practice in the aviation industry. Utilizing one of the major oversight programs such as IS-BAO or Wyvern, the aviation program will have "fresh" eyes to meet a standard of safety recognized through the industry.

4. **"Best Practices" Training**

Implementing best safety practices from throughout the industry from a variety of sources helps mitigate any number of risks and their drivers continuously and in support of the SMS approach to safety management. It is low cost, pro-active in nature, and able to be immediately pursued.

# 6 Proposed Risk Mitigation Plan

The 2015 baseline mitigations outlined in Section 5 will continue to be performed in the proposed plan, in most cases, to maintain the current residual risk level. In addition, SDG&E is proposing expanded and new mitigations to further address the risk of Aviation Incident. These incremental changes, along with updates about other controls are described in below and in Section 6.

SDG&E's proposed plan has many benefits in applying, implementing, and evolving the operational framework envisioned for mitigating the risk of Aviation Incident. By adopting industry best practices that touch upon SMS, Crew Resource Management (CRM), and aircraft with redundant capabilities that provide much greater protection against the most common fatal failure types, SDG&E will take a huge leap forward in eliminating errors that can be attributed to the majority of aviation accidents.[23] While helicopter accident rates are considered among the lowest in aviation (due to many factors, including less flight hours by amateur pilots, and a requirement for more training than much of aviation), Vertical Take-Off and Landing (VTOL) flight is still prone to very specific incident drivers (hazards), including airworthiness or maintenance problems, situational-awareness reduction, human error, a lack of area of operation knowledge, and problems of non-detailed communications. By adopting the measures above – especially through the implementation of a robust SMS that captures hazards, analyzes them for risk, and mitigates risk before they become accidents – safety and security of the Aviation program and its tangential operations will follow.

Likewise, it is an industry practice to invite third party auditing and internal on-site verification for all operations. These elements provide the ongoing external expertise to identify hazard drivers that organizations often become accustomed to and don't see directly. These elements are vital to the Safety Assurance component of SMS that can be very difficult to develop and are considered an industry best practice throughout aviation.

SDG&E's proposed plan is further discussed in detail below.

1. **Aviation Safety Management Systems**

   SDG&E will continue with its aviation SMS. Developing a robust SMS program enables the support and expansion of manned aviation activity throughout SDG&E strategic operations. The FAA has identified SMS as the main enabling operational approach to aviation operations that provides succinct and successful operations. This will allow continued integration of operations

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[23] Wiegmann, D. et. Al; Federal Aviation Administration. Human Error and General Aviation Accidents: A Comprehensive, Fine-Grained Analysis using HFACS. December 2005. https://www.faa.gov/data_research/research/med_humanfacs/oamtechreports/2000s/media/0524.pdf.

through the incorporation of data processing, fleet management, and operational training, for all operations. SMS comes with a cost, but the return on investment comes through continued safety, proactive hazard identification, and minimized loss through incidents and accidents. By avoiding even one fatal accident, the cost of the program is recovered.[24]

Additionally, according to Subject Matter Experts, Safety Management Systems is the future of all aviation operations, and will likely be required by FAA in accordance with International Civil Aviation Organization, Annex 19.[25] Currently, Part 121 and 135 aircraft operators are required to implement SMS into their operations; however, the FAA has expressed an interest in continuing to implement SMS through all commercial operations. SDG&E will be positioned to avoid the risk of a costly program overhaul when the proposed requirement becomes reality; avoiding a necessity to change the procedures in place that often leads to residual and unidentified risk. Implementing a robust SMS mitigates the following risks: asset failure, policy or procedure failure, employee incident, contractor incident, and public incident.

**2. Job Site Observation Program**

This program is also continuing from the 2015 baseline control. Line Operations Safety Audits (LOSA) and job site inspections will be adapted and integrated into the ongoing SMS oversight program to maintain policies and procedures without organizational drift or the normalization of deviance – which is a major contributor to incidents and accidents in aviation as noted above. This increased oversight will mitigate the risk of an employee or contractor incident related to helicopter operations.

**3. Service Provider Audit Program**

This program is also continuing from the 2015 baseline control. Utilizing experienced aviation consultants to conduct audits is a function of "Safety Risk Management" and "Safety Assurance." The "Safety Risk Management" portion deals with continuing to update existing procedures. Procedures will be updated to require that audits be performed before a contractor flies on company property for the first time and that all contracted vendors are audited annually.

[24] https://www.rand.org/content/dam/rand/pubs/reports/2007/R3421.pdf.
[25] EASA. ICAO ANNEX 19. https://www.easa.europa.eu/system/files/dfu/ICAO-annex-19.pdf Accessed 2016.

4. **Purchase a Twin-engine Helicopter**

Purchasing a twin-engine helicopter for SDG&E use provides a unique opportunity in aviation to enable a dual-redundant system where single-point failure exists; thereby cutting the frequency of an accident (if one were to occur) by half. This increases the SDG&E safety margin by 2-fold in cases of engine failure (one of the most important safety increases possible), as the engine point of failure leads directly to loss of life and expansive costs to operation, mission, personnel, and litigation. It is likely that if a single engine helicopter accident were to occur, the aircraft in question would enter immediately into an autorotation and be required to land directly below the current location, whereas a twin-engine helicopter may continue powered flight to a safe landing. As an aviation accident at the catastrophic level may potentially harm the public and/or employees and contractors, as well as reach the tens of millions of dollars (if striking another aircraft, or killing multiple individuals), reducing the likelihood of such an event is paramount.[26] SDG&E strives to operate all its assets safely and in a manner that will avoid potential serious injuries or fatalities. It is estimated a twin-engine helicopter will help reduce the frequency of this type of an accident from once every 10 years to once every 20 years.[27] This represents a significant avoidance of a safety incident (lives both in the air and on the ground), and costs associated with physical damage, extensive litigation, and reputation.

Operating a twin-engine helicopter with advanced avionics will provide the Company with a reduction in the risk of engine failure and many human factors, due to an increase in automation. As human error is considered to be a causal factor in roughly 90% of all aviation accidents; reducing that occurrence in any form pays tremendous dividends. Further, if an accident were to occur that is related to single engine failure, the resulting accident would be catastrophic in a single point failure configuration. For a twin-engine aircraft, the risk is still serious, however the aircraft has an extended ability to fly and the severity, therefore, is significantly reduced.

5. **Aviation Safety Training and Dispatch and Advisor Roles within ASD**

Training and operational codifications provide the policy and procedure foundation upon which all operations must be based. It is estimated the training will require constant development in the early and middle phases of program development. The training program consists of an initial training manual for internal use of pilot development, continued training costs for currency and performance development, and case-by-case skills performance development. Training is the core element of the fourth pillar (Safety Promotion) of SMS and, therefore, required in an on-going programmatic methodology that goes beyond that required by other operational core competencies of SDG&E. Further, providing an Aviation advisor and leadership role continues

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[26] Schuffman, P et al. Direct and indirect cost of general aviation crashes. https://www.ncbi.nlm.nih.gov/pubmed/12234034.

[27] Measuring Safety in Single- and Twin Engine Helicopters. http://flightsafety.org/fsd/fsd_aug91.pdf.

to reinforce the needed management engagement and guidance at the senior supervisor level, required by SMS in both the ICAO and FAA frameworks.

This mitigation addresses the risk of communication errors, lack of codified rules, and provides institutional foundation for operations.

### 6. Currency and Proficiency Training with New Helicopter

The purpose of currency and proficiency training is to socialize best procedural practices and promote institutional knowledge and safety. While it is a vital element in any aviation operation, it is even more important for pilots unfamiliar with a new aircraft. Familiarity within a system fosters good flying, but it takes time and vigilance through training to cultivate that ease of flight and expertise. The FAA went so far as to identify training problems and insufficient training as a direct contributor to many aviation accidents throughout the United States.[28] As new systems are introduced into the flight operations environment, training will need to be incorporated to educate and adapt pilots to new policies, procedures, and technological elements.

The mitigation addresses the drivers of equipment misuse, recurrent training deficiencies, and limitations operational knowledge.

## 7 Summary of Mitigations

Table 4 summarizes the 2015 baseline risk mitigation plan, the risk driver(s) a control addresses, and the 2015 baseline costs for Aviation Incident. While control or mitigation activities may address both risk drivers and consequences, risk drivers link directly to the likelihood that a risk event will occur. Thus, risk drivers are specifically highlighted in the summary tables.

SDG&E does not account for and track costs by activity, but rather, by cost center and capital budget code. So, the costs shown in Table 4 were estimated using assumptions provided by SMEs and available accounting data.

[28] Federal Aviation Administration. Fact Sheet General Aviation Safety. July 30, 2014 Accessed 10/4/2016 http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=16774.

### Table 4: Baseline Risk Mitigation Plan[29]
(Direct 2015 $000)[30]

| ID | Control | Risk Drivers Addressed | Capital[31] | O&M | Control Total[32] | GRC Total[33] |
|---|---|---|---|---|---|---|
| 1 | Aviation Safety Management System | • On-going Hazards<br>• Inadequate Policies or Procedures | $20 | $30 | $50 | $50 |
| 2 | Job Site Observation Program | • Pilot Error<br>• Crew or other support personnel error<br>• Communication Issues | n/a | 10 | 10 | 10 |
| 3 | Service Provider Audit Program | • Aircraft/equipment failure (due to either maintenance or non-maintenance-related causes<br>• Crew or other support personnel error<br>• Inadequate Policies and Procedures<br>• Communication Issues | n/a | 10 | 10 | 10 |
| 5 | "Best Practices" Training | • Communication Issues<br>• Situational Awareness<br>• Crew or other support personnel error | 10 | 0 | 10 | 10 |

[29] Recorded costs were rounded to the nearest $10,000.
[30] The figures provided in Tables 4 and 5 are direct charges and do not include Company overhead loaders, with the exception of vacation and sick. The costs are also in 2015 dollars and have not been escalated to 2016 amounts.
[31] Pursuant to D.14-12-025 and D.16-08-018, the Company is providing the "baseline" costs associated with the current controls, which include the 2015 capital amounts. The 2015 mitigation capital amounts are for illustrative purposes only. Because projects generally span several years, considering only one year of capital may not represent the entire mitigation.
[32] The Control Total column includes GRC items as well as any applicable non-GRC jurisdictional items. Non-GRC items may include those addressed in separate regulatory filings or under the jurisdiction of the Federal Energy Regulatory Commission (FERC).
[33] The GRC Total column shows costs typically presented in a GRC.

| ID | Control | Risk Drivers Addressed | Capital[31] | O&M | Control Total[32] | GRC Total[33] |
|---|---|---|---|---|---|---|
| | | • Operational Limitations | | | | |
| | ***TOTAL COST*** | | $30 | $50 | $80 | $80 |

The costs identified in the Table 4 were primarily gathered using data from SDG&E's accounting systems.

Table 5 summarizes SDG&E's proposed mitigation plan and associated projected ranges of estimated O&M expenses for 2019, and projected ranges of estimated capital costs for the years 2017-2019. It is important to note that SDG&E is identifying potential ranges of costs in this plan, and is not requesting funding approval. SDG&E will request approval of funding, in its next GRC. There are non-CPUC jurisdictional mitigation activities addressed in RAMP; the costs associated with these will not be carried over to the GRC.

**Table 5: Proposed Risk Mitigation Plan[34]**
**(Direct 2015 $000)**

| ID | Mitigation | Risk Drivers Addressed | 2017 - 2019 Capital[35] | 2019 O&M | Mitigation Total[36] | GRC Total[37] |
|---|---|---|---|---|---|---|
| 1 | Aviation Safety Management Systems | • On-going Hazards<br>• Inadequate Policies or Procedures | n/a | $60 - 80 | $60 - 80 | $60 - 80 |
| 2 | Job Site Observation Program | • Pilot Error<br>• Crew or other support personnel error<br>• Communication Issues | n/a | 10 - 20 | 10 - 20 | 10 - 20 |
| 3 | Service Provider Audit Program | • Aircraft/equipment failure (due to either | n/a | 18 - 24 | 18 - 24 | 18 - 24 |

[34] Ranges of costs were rounded to the nearest $10,000.
[35] The capital presented is the sum of the years 2017, 2018, and 2019 or a three-year total. Years 2017, 2018 and 2019 are the forecast years for SDG&E's Test Year 2019 GRC Application.
[36] The Mitigation Total column includes GRC items as well as any applicable non-GRC items.
[37] The GRC Total column shows costs typically represented in a GRC.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | maintenance or non-maintenance-related causes<br>• Crew or other support personnel error<br>• Inadequate Policies and Procedures<br>• Communication Issues | | | | |
| **4** | Purchase a Twin-Engine Helicopter | • Aircraft/equipment failure (due to either maintenance or non-maintenance-related causes<br>• Pilot Error | 7,650 - 11,050 | 200 - 260 | 7,850 - 11,310 | 7,850 - 11,310 |
| **5** | Aviation Safety Training | • Pilot Error<br>• Crew or other support personnel error<br>• Communication Issues | n/a | 18 - 23 | 18 - 23 | 18 - 23 |
| **6** | Currency and Proficiency Training with New Helicopter | • Pilot Error<br>• Crew or other support personnel error<br>• Communication Issues | n/a | 3 - 4 | 3 - 4 | 3 - 4 |
| | ***TOTAL COST*** | | $7,650 - 11,050 | $310 - 410 | $7,960 - 11,460 | $7,960 - 11,460 |

| | |
|---|---|
| ☐ | Status quo is maintained |
| ☐ (shaded) | Expanded or new activity |
| * | Includes one or more mandated activities |

Generally, the costs were developed utilizing the subject matter experts' knowledge of how much similar projects and programs will cost to implement. As seen in Table 5, the SMS and the Job Site Observation Program are maintained or even slightly declining compared in the 2015 baseline levels. The Service Provider Audit Program is expanding and the remaining proposed mitigations are new. The range of costs provides flexibility as SDG&E implements these programs and finalizes the scope of these activities.

1. Aviation SMS
   The costs associated with the SMS provided in Table 5 were developed as a result of previous work and proposals for work by third-party vendors, and vetted through inter-industry discussions for appropriateness. Accordingly, the forecast methodology that was selected was base year (2015) as it was most representative of this previous work.

2. Job Site Observation Program
   A base year forecast methodology was selected for this mitigation. The costs provided in Table 5 are in line with aviation industry estimates and are needed elements of any robust safety program.

3. Service Provider Audit Program

   The costs for this activity as presented in Table 5 include expert time and travel as well as the certification itself which will provide insight, approval, and recognition, enabling flight operations for SDG&E.

4. Purchase Twin-Engine Helicopter
   The forecasted costs for the purchase of a twin-engine helicopter were zero-based. Subject matter experts researched the acquisition cost of a twin-engine helicopter using various models, makers, and condition of asset. The capital costs will be largely dependent on aircraft availability and cost of bundled systems.

5. Aviation Safety Training
   The costs for this mitigation were forecasted based on vendor proposals and industry standard rates, as well as the number of hours for labor expected for SDG&E employees to implement the training.

6. Currency and Proficiency Training with New Helicopter
   Training costs were developed through an industry survey and discussion with SMEs responsible for this type of training. The cost of not training and still acquiring the new aircraft is in line with accident data, as it is likely insufficient training would beget an aviation incident ($Millions).

# 8 Risk Spend Efficiency

Pursuant to D.16-08-018, the utilities are required in this Report to "explicitly include a calculation of risk reduction and a ranking of mitigations based on risk reduction per dollar spent."[38] For the purposes of this Section, Risk Spend Efficiency (RSE) is a ratio developed to quantify and compare the

[38] D.16-08-018 Ordering Paragraph 8.

effectiveness of a mitigation at reducing risk to other mitigations for the same risk. It is synonymous with "risk reduction per dollar spent" required in D.16-08-018.[39]

As discussed in greater detail in the RAMP Approach chapter within this Report, to calculate the RSE the Company first quantified the amount of Risk Reduction attributable to a mitigation, then applied the Risk Reduction to the Mitigation Costs (discussed in Section 7). The Company applied this calculation to each of the mitigations or mitigation groupings, then ranked the proposed mitigations in accordance with the RSE result.

### *8.1 General Overview of Risk Spend Efficiency Methodology*

This subsection describes, in general terms, the methods used to quantify the *Risk Reduction*. The quantification process was intended to accommodate the variety of mitigations and accessibility to applicable data pertinent to calculating risk reductions. Importantly, it should be noted that the analysis described in this chapter uses ranges of estimates of costs, risk scores and RSE. Given the newness of RAMP and its associated requirements, the level of precision in the numbers and figures cannot and should not be assumed.

#### 8.1.1 Calculating Risk Reduction

The Company's SMEs followed these steps to calculate the Risk Reduction for each mitigation:

1. **Group mitigations for analysis:** The Company "grouped" the proposed mitigations in one of three ways in order to determine the risk reduction: (1) Use the same groupings as shown in the Proposed Risk Mitigation Plan; (2) Group the mitigations by current controls or future mitigations, and similarities in potential drivers, potential consequences, assets, or dependencies (e.g., purchase of software and training on the software); or (3) Analyze the proposed mitigations as one group (i.e., to cover a range of activities associated with the risk).
2. **Identify mitigation groupings as either current controls or incremental mitigations:** The Company identified the groupings by either current controls, which refer to controls that are already in place, or incremental mitigations, which refer to significantly new or expanded mitigations.
3. **Identify a methodology to quantify the impact of each mitigation grouping:** The Company identified the most pertinent methodology to quantify the potential risk reduction resulting from a mitigation grouping's impact by considering a spectrum of data, including empirical data to the extent available, supplemented with the knowledge and experience of subject matter experts. Sources of data included existing Company data and studies, outputs from data modeling, industry studies, and other third-party data and research.
4. **Calculate the risk reduction (change in the risk score).** Using the methodology in Step 3, the Company determined the change in the risk score by using one of the following two approaches to calculate a Potential Risk Score: (1) for current controls, a Potential Risk Score was calculated that represents the increased risk score if the current control was not in place; (2) for incremental

[39] D.14-12-025 also refers to this as "estimated mitigation costs in relation to risk mitigation benefits."

mitigations, a Potential Risk Score was calculated that represents the new risk score if the incremental mitigation is put into place. Next, the Company calculated the risk reduction by taking the residual risk score (See Table 3 in this chapter.) and subtracting the Potential Risk Score. For current controls, the analysis assesses how much the risk might increase (i.e., what the potential risk score would be) if that control was removed.[40] For incremental mitigations, the analysis assesses the anticipated reduction of the risk if the new mitigations are implemented. The change in risk score is the risk reduction attributable to each mitigation.

#### 8.1.2 Calculating Risk Spend Efficiency

The Company SMEs then incorporated the mitigation costs from Section 7. They multiplied the risk reduction developed in subsection 8.1.1 by the number of years of risk reduction expected to be realized by the expenditure, and divided it by the total expenditure on the mitigation (capital and O&M). The result is a ratio of risk reduction per dollar, or RSE. This number can be used to measure the relative efficiency of each mitigation to another. Figure 3 shows the RSE calculation.

**Figure 3: Formula for Calculating RSE**

$$Risk\ Spend\ Efficiency = \frac{Risk\ Reduction * Number\ of\ Years\ of\ Expected\ Risk\ Reduction}{Total\ Mitigation\ Cost\ (in\ thousands)}$$

The RSE is presented in this Report as a range, bounded by the low and high cost estimates shown in Table 5 of this chapter. The resulting RSE scores, in units of risk reduction per dollar, can be used to compare mitigations within a risk, as is shown for each risk in this Report.

### *8.2 Risk Spend Efficiency Applied to This Risk*

SDG&E analysts used the general approach discussed in Section 8.1 above, in order to assess the RSE for the Aviation risk. The RAMP Approach section in this Report provides a more detailed example of the calculation used by the Company.

The risk assessment team used two groupings of the mitigations for the analysis. The first consists of a mandated SMS program, its associated training, audits, and on-site observation. This is a current control. The second is an equipment upgrade. This is an incremental mitigation. Much of this analysis was based on estimates and research conducted by SDG&E subject matter experts.

The mitigations groupings included:

(a) Effective SMS program (include training, on-site observation, and audits)

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[40] For purposes of this analysis, the risk event used is the reasonable worst case scenario, described in the Risk Information section of this chapter.

- Aviation SMS which is inclusive of a contractor qualification process and further development and implementation of real-time flight management control.
- Implement an aviation job site observation program.
- Develop service provider audit program to conduct and "as needed" audits.
- Conduct currency and proficiency training with helicopter.
- Conduct audits of ASD's SMS utilizing a reputable aviation audit service.
- Provide aviation safety training for dispatch and advisor roles within ASD.
- Utilize an aviation safety contractor to develop governing documents for internal and external aviation operations.

(b) More reliable equipment

- Purchase a twin-engine helicopter to the maximum extent practical.

- Analysis of Effective SMS Program (current controls)

This mitigation grouping consists of an SMS program and activities to ensure its effectiveness. These include training, audits, and routine on-site observation to ensure that the program is being followed. FAA provides guidelines on what elements constitute an SMS program and SDG&E must comply with each of these elements. SDG&E conducts audits to ensure that each of these guidelines in its SMS are being followed by employees and contractors.

The risk team estimated that if training were discontinued for three years, the effectiveness of this risk would drop by 30%. This was based on an assumption of diminishing effectiveness of previous training, using SME input and corroboration.

Regarding on-site observation, changes in pilots or contractors have historically been made based on flight observations. The program has successfully identified inadequate contractors. Out of 11 potential contractors, four are no longer permitted to work for SDG&E.

Based on these factors, the risk team's SMEs estimated that, if these mitigations were discontinued, the likelihood of an incident would increase by 33%.

- Analysis of More Reliable Equipment (incremental mitigations)

SDG&E staff conducted a cost benefit analysis of the purchase of a twin-engine helicopter using a 10-year time horizon. Due to factors such as autopilot and engine redundancy, the likelihood reduction was estimated to be 50%.

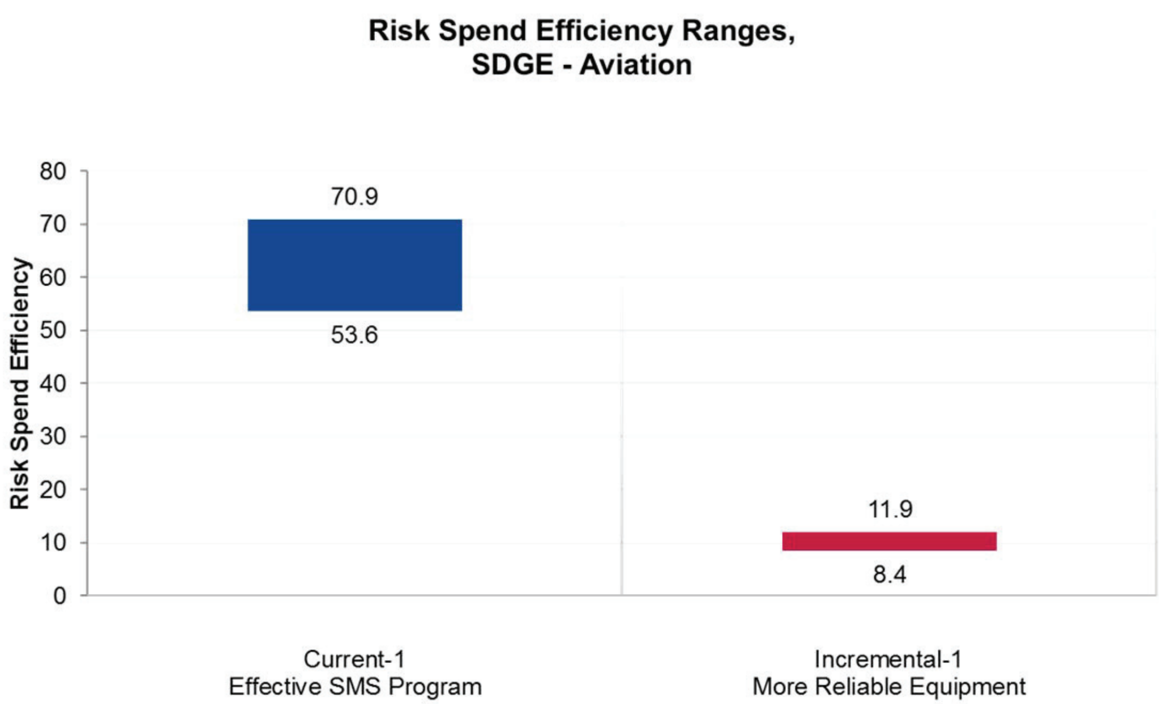
### *8.3 Risk Spend Efficiency Results*

Based on the foregoing analysis, SDG&E calculated the RSE ratio for each of the proposed mitigation groupings. Following is the ranking of the mitigation groupings from the highest to the lowest efficiency, as indicated by the RSE number:

1. Effective SMS program (current controls)
2. More reliable equipment (incremental mitigations)

Figure 4 displays the range[41] of RSEs for each of the SDG&E Aviation risk mitigation groupings, arrayed in descending order.[42] That is, the more efficient mitigations, in terms of risk reduction per spend, are on the left side of the chart.

**Figure 4: Risk Spend Efficiency**




## 9 Alternatives Analysis

An analytical comparison of the feasibility, affordability impacts, safety and environmental risks associated with the proposed mitigations and their alternatives was performed to determine the preferred solutions. Due to the serious safety concerns of aviation incidents, an effort was made not to consider

[41] Based on the low and high cost ranges provided in Table 5 of this chapter.

[42] It is important to note that the risk mitigation prioritization shown in this Report, is not comparable across other risks in this Report.

the status quo as a plausible alternative. Instead, addition of new activities was selected to derive alternatives during the selection process.

### *9.1 Alternative 1 – Continued Use of Single Engine Helicopter*

The alternative to purchasing a twin-engine aircraft is to utilize a single engine helicopter. This alternative is less expensive, currently available, requires less maintenance, and has a higher degree of maneuverability compared to the proposed plan. However, the single engine has significant flaws including multiple single points of failures, reduced payload, and legacy avionics. Accident likelihood is believed to be increased at the systems levels. As such, the twin engine helicopter is preferred because it will reduce the likelihood of a potential safety incident related to aviation.

### *9.2 Alternative 2 – Development of In-House Flight Program*

The second alternative would be for SDG&E to develop an in-house helicopter flight program. This alternative would require significant start-up costs, additional personnel, and result in increased liability. It would also require extensive overhead cost and resource development to meet administrative, maintenance, and management requirements currently not experienced. Note also that the twin engine helicopter, mentioned above, will be managed and operated by SDG&E's exclusive use-contractor.

SDG&E does not need to bring the helicopter program in-house as the core competencies of the aircraft flight contractors allow them to perform at a high level, while SDG&E supports operations in cooperation. The costs associated with bringing the flight program in-house completely are prohibitive. It is not in the interest of SDG&E to focus on internal flight operations, and the cost is not justified.