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IVANPAH SOLAR ELECTRIC GENERATING SYSTEM
GLARE INVESTIGATION

Staff Report

CALIFORNIA
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IVANPAH SOLAR ELECTRIC GENERATING SYSTEM GLARE INVESTIGATION

INTRODUCTION

This report is in response to complaints made by pilots flying in the vicinity of the Ivanpah Solar Electric Generating System (ISEGS) regarding a potential hazard from significant glare from the facility. California Energy Commission staff (staff) has investigated these complaints and made recommendations in this report to mitigate significant glare produced by ISEGS.

BACKGROUND

The ISEGS is a 370-megawatt (MW) solar power tower project located on land managed by the U.S. Bureau of Land Management (BLM) in the Mojave Desert, near the Nevada border, in San Bernardino County. It was certified by the California Energy Commission on September 22, 2010, and received a Record of Decision for a Right-of-Way (ROW) grant from the BLM on October 7, 2010. Construction of the facility began on October 7, 2010, and the facility started commercial operations on December 31, 2013. ISEGS is located in San Bernardino County, California and is owned in partnership by NRG Energy, Google, and Brightsource, through three limited liability companies: Solar Partners I, Solar Partners II, and Solar Partners VIII (Solar Partners).

ISEGS consists of three independent powerplants sharing common facilities and using heliostats that focus solar energy on central solar power tower receivers near the center of each of the heliostat arrays. Ivanpah 1 is a nominal 120 MW powerplant located on approximately 914 acres with a heliostat array consisting of approximately 53,500 heliostats. Ivanpah 2 and 3 are nominal 125 MW powerplants located on approximately 1,097 and 1,227 acres, respectively, each with heliostat arrays consisting of approximately 60,000 heliostats. Each heliostat is comprised of two mirrors the size of a garage door that are affixed to a large steel frame. The heliostat is mounted on a pylon and positioned by a tracking drive which moves the mirrors to track the sun in two directions and reflect it towards the tower's solar receiver.

The heliostat array of each unit is arranged around a single, centralized, solar power tower that is 459 feet in height, including a solar receiver steam generator with an upper steam drum and protective ceramic insulation panels on top. During operations, the solar field and power generation equipment start each morning after sunrise and shut down in the evening, when solar insolation drops below the level required to keep the turbine online.

The heliostats are collectively controlled by the Solar Field Integrated Control System which sends signals to groups of heliostats to move them to various states, including the following heliostat functions:

- **Stow**: (long-term hold/overnight hold/cleaning and maintenance): The heliostats are rotated down into the stow position, facing randomly to the east for preparation

of the sunrise, with the mirror surface 5 degrees past vertical (that is, inclined slightly toward the ground), to prevent dust from covering the mirror surface and therefore reducing cleaning frequencies;

- **Standby**: The heliostats are focused on the standby aim points on the side of the tower, forming a ring at, or near, the height of the tower;
- **Normal Operation**: All heliostats are focused on the receiver, except for heliostats in standby, stow or calibration position;
- **Transition Mode**: All heliostats are following a path defined for the transition that does not concentrate a beam intensity of more than 250 W/m^2 above 1,459 feet (445 meters) in altitude (459-foot tower height plus 1,000-foot Federal Aviation Administration (FAA) rule prohibiting flight within 1,000 feet of any manmade obstruction); and
- **Calibration Mode**: Generally done with an artificial light beam directed to the tower structure with individual heliostats at calibration aimed at the cameras located on the tower.

Because ISEGS involves the use of mirrors (heliostats) to direct reflected sunlight at power tower receivers, the potential exists for glare to be observed by motorists on adjacent roads and by aircraft pilots. Glare is the difficulty in seeing in the presence of bright light such as direct or reflected sunlight or other light. The September 2010 Energy Commission Decision (Decision) for the ISEGS addressed two different aspects of glare in the Traffic and Transportation section (CEC 2010)[1]:

(1) the potential for light to result in damage to the retina; and

(2) luminance or brightness perceived by viewers.

The Decision noted that there are no standards or regulations specific to light reflected from solar panels. Thus, the Commission looked to principles and procedures developed by Sandia National Laboratories and Sandia's determination of maximum permissible exposure (MPE) limits for reflected sunlight. The Commission applied this information to the demonstrated evidence establishing that with the varying angles of the sun and ability of the mirrors to pivot in order to focus upon the power tower receivers, the continuous exposure danger zone extends to those on the ground and those flying above the mirrors. The Commission adopted Condition of Certification TRANS-3 requiring the project owner to prepare a Heliostat Positioning Plan (HPP) to address the potential for exposure to levels above the MPEs.

This required condition of certification took into consideration the FAA's review of the seven originally proposed power towers, which found no obstruction hazards to air navigation[2]. However, the FAA did not address the issue of glare. The discussion of

[1] References include an electronic link or are contained in the Attachments portion of this report.
[2]The FAA recommended that each tower be marked with aviation warning lights, which were installed as required by Condition of Certification TRANS-5.

***** Report cover photograph taken by staff on May 8, 2014.

glare in the Decision was based on information available at the time and supported the conclusion that aviators flying more than 1,000 meters (3280 feet) above the project would not be in danger and could simply look away from the facility (CEC 2010). To date, the HPP has not been finalized by NRG Energy (ISEGS majority owner) or approved by the Energy Commission. NRG has not responded to staff's most recent comments, and the HPP will need to be modified, after additional engineering modifications to the standby heliostats have been implemented as discussed below.

One of the provisions of the HPP requires the preparation of a monitoring plan that provides requirements and procedures to document, investigate, and resolve, legitimate complaints regarding glare. The Clark County Department of Aviation (CCDOA) in Nevada used this provision to notify the project owner and the applicable agencies of glare complaints by pilots, as described below.

GLARE COMPLAINTS

In a letter dated March 10, 2014, the CCDOA informed the BLM Needles Field Office, the Energy Commission ISEGS Compliance Project Manager, and BrightSource Energy (the ISEGS owner at the time) of two complaints concerning glare from ISEGS (CCDOA 2014a).[3]

The first complaint, from August 2013, involved a small transport airplane that departed from Boulder City Airport in Nevada and flew towards ISEGS. The pilot reported being distracted and momentarily blinded by the sun reflecting off the mirrors. The second complaint, also from August 2013, was from an air traffic controller reporting that a member of the flight crew of a commercial airliner complained about the brightness, stating that it was "nearly blinding."

A third complaint was received on April 9, 2014, by the National Aeronautics and Space Administration (NASA)[4], Aviation Safety Reporting System (ASRS) Director, Linda Connell, regarding glare generated by ISEGS during the month of March 2014 (NASA ASRS 2014a). NASA's report claimed that a flight crew of a corporate turbojet on approach to McCarran International Airport (Las Vegas) was temporarily blinded by bright lights (reflections) from the ground at ISEGS. The complaint noted that when the crew reported the event to Air Traffic Control, the response was "Yes, we get lots of complaints."

On September 2, 2014, staff received five additional reports of glare generated by ISEGS from the NASA ASRS Director (NASA ASRS 2014b). The reports were based on events during June through August 2014. Four of the five pilots reported experiencing significant or blinding glare while flying within 15 miles of ISEGS at altitudes ranging from 8,600 feet to 18,000 feet MSL. One pilot noted flying this route

[3] The BLM ROW grant does not include glare complaint requirements for ISEGS; however, the BLM is identified in the HPP as an agency that must be notified in the event of a complaint.
[4] NASA is the agency that administrates the Aviation Safety Reporting System (ASRS) to collect, analyze, and respond to voluntarily submitted aviation safety incident reports in order to lessen the likelihood of aviation accidents.

several times a week and experiencing these hazards every time the sun is visible. Another pilot saw the glare and thought it was annoying and a distraction.

On October 17, 2014, staff received an additional report from the NASA ASRS Director about a glare complaint in September 2014. The report stated: “While approaching the ISEGS, a pilot and flight crew member complained the light generated from the facility was blinding to both pilot and crew. The bright light was almost blinding from a distance of 20 plus miles. This facility generates three bright lights on a 360 degree arc around the facilities. The light from the facility was very similar to that seen when looking at a welder. One crew member complained they only looked at it briefly and felt it hurt their eyes in a manner similar to that caused by snow blindness. All crew members were wearing sunglasses which did not appear to reduce the glare. The pilot and crew members agree that this facility poses hazards to aviation and passengers” (NASA ASRS 2014c).

In response to receiving the March 10, 2014 letter, NRG launched an investigation of the ISEGS glare issue pursuant to Condition of Certification TRANS-3 and is attempting to solve the problem by implementing some engineering modifications and proposing others. It is staff’s understanding that some engineering modifications intended to reduce the intensity of glare were implemented at ISEGS in June or July 2014. However, given the recent pilot reports from August and September 2014, significant glare was still being generated after the modifications were in place.

BRIGHTSOURCE/NRG INVESTIGATION

As noted above, ISEGS Condition of Certification TRANS-3 requires the project owner to prepare and implement an HPP that provides requirements and procedures to document, investigate, and resolve, legitimate complaints regarding glare.

On March 20, 2014, NRG Energy responded to the CCDOA with a preliminary investigation and a request for additional information regarding the locations of the aircraft cited in the complaints. NRG subsequently expanded its investigation to include the hiring of Dr. Clifford Ho, of Sandia National Laboratories, to evaluate the complaints and prepare revised heliostat positioning and power tower receiver luminance and monitoring plans required by Conditions of Certification TRANS-3 and TRANS-4 (CEC 2010).

On July 17, 2014, NRG provided the Energy Commission with an HPP report titled *Evaluation of Glare at the Ivanpah Solar Electric Generating System* (Sandia 2014a). The report by Cliff Ho and Associates, discusses aerial and ground-based surveys of glare and related results.

Based on aerial and ground-based surveys, the report presents the following conclusions:

- Aerial Surveys
    - o Heliostats in standby mode can cause glare to aerial observers (pilots).

    - Glare from heliostats can cause after-images at far distances (up to 6 miles in their helicopter surveys).
    - Glare was visible from multiple heliostats in standby mode.
    - Glare from Unit 1 originated from standby heliostats on both sides of the receiver during the survey on April 24, 2014.The glare from the illuminated receivers was small compared to the glare from the standby heliostats.
- Ground Surveys
    - Drive-by surveys at three different times of the day did not reveal any ocular hazards.
    - All data from receiver glare showed a low potential for after-image.
    - Glare from an occasional rogue heliostat was visible from Interstate15, but it was not perceived to be a significant ocular hazard.
- Modeling of both specular reflections from heliostats and diffuse reflections from the receiver predicted retinal irradiances, subtended angles, and ocular impacts that were consistent with the results of the aerial and ground surveys.

The report also presents recommended measures to mitigate the potential impacts of glare from ISEGS. In particular, the report recommends that BrightSource and NRG Energy make the following engineering modifications:

- Increase the number of aim points near the receiver and have adjacent heliostats point to different locations so that the number of glare-producing heliostats visible from the airspace above is minimized at all locations.
- Position heliostats vertically or in other orientations that minimize glare.
- Bring heliostats up to standby positions at the top of the receiver sequentially as needed, to avoid having a large number of heliostats reflecting light into the airspace above.
- Incorporate a glare shield near the receiver that can serve as both the aim point for heliostats in standby mode and a preheater for the water entering the tower.

On July 25, 2014, staff received an e-mail from Dr. Ho about an aerial survey by helicopter taken on July 22, 2014, to observe glare after engineering modifications had been implemented at ISEGS Units 1 and 2 (but not 3), pursuant to the recommendations in his report (Sandia 2014b). According to the e-mail, Dr. Ho found that there was still glare visible from all the units but that there were differences in the glare from modified Units 1 and 2 as compared to unmodified Unit 3. When viewed from the north, east, and west of the solar plant, glare from Units 1 and 2 was not as significant as that seen at the unmodified Unit 3. He believes that with further modifications, the impact of the glare can be further reduced or mitigated.

On August 29, 2014, Dr. Ho sent staff a report titled *Evaluation of Glare at the Ivanpah Solar Electric Generating System – 2nd Flyover on July 22, 2014* (Sandia 2014c). The report described glare monitoring, as summarized below:

- New heliostat standby aiming strategies were implemented for Units 1 and 2 while Unit 3 was unchanged.
- The flyover on July 22, 2014 showed that the points of glare from Units 1 and 2 were more spread out than Unit 3.
- Ocular hazard analysis showed "low potential for after-image" for all photos of Units 1, 2, 3. However, Dr. Ho thought that the glare was still bright enough to cause complaints, and the time of day for the July 22 flyover was later (close to noon) than the April 24 survey, which was around 9 AM. Dr. Ho stated that there is a need to consider additional standby aiming strategies and protocols.

The report also included several next steps:

- Hold a meeting with Energy Commission staff, NRG, BrightSource, Sandia, and other stakeholders to review results and discuss a path forward regarding new standby aiming strategies and procedures, possibility of using glare shields, and reducing the number of standby heliostats that face directly toward the sun (as these produce the most glare).
- Implement new standby aiming strategies and perform flyovers to characterize impacts on glare.
- Identify an optimal solution for reducing glare and revise the HPP accordingly for review and approval.

Staff agrees in concept with Mr. Ho's report, including his recommended mitigation measures, but disagrees with his statement about the "low potential for after-image," based on staff's May 8, 2014, overflight of ISEGS which included repeated after-images, and the recent pilot complaints about significant glare generated by ISEGS.

STAFF INVESTIGATION AND FIELDWORK

Staff retained Dr. Gregg Irvin, a glint and glare consultant, and has been working with the FAA, Caltrans Aeronautics, CCDOA, and NASA ASRS, to independently investigate and evaluate the reported incidents of glare. Staff has also conducted field trips to the project site on two separate occasions (including an aerial flyover) to observe glare from the project and air traffic occurrences near and over the site.

As a result of its investigation, staff found that during normal ISEGS power operations, pilots flying through the local airspace can experience elevated levels of glare sufficient to affect aviation safety. Safety risks from the glare include temporary blindness that prevents pilots from searching surrounding airspace for other aircraft and an inability to read, adjust and monitor instruments and gauges in the cockpit. Although the full impact

on airborne operations is unknown, staff determined that the glare observed and experienced during overflight is significant (CEC 2014b).

Staff conducted a field trip to ISEGS on March 10 and 11, 2014. During a four-hour period on March 10, staff observed 59 high altitude commercial aircraft over the project area. Staff was advised by Caltrans Aeronautics staff that most of the high altitude aircraft using this air corridor are at 30,000-36,000 feet MSL (Caltrans 2014a). The observed air route is a major corridor for flights departing from or arriving at Los Angeles area airports. Flights from Los Angeles to Denver, Chicago, the upper Midwest, New York, and Northern Europe, fly over ISEGS. Additionally, flights from the Pacific Northwest to Phoenix, Dallas, and Mexico, fly over Ivanpah. Based upon information provided by the FAA, there are approximately 12,000 aircraft flying over ISEGS per month (FAA 2014d). Additionally, there are many regional carriers flying over the ISEGS (approximately 1-3 every hour). Most of these are traveling to, or flying from, Las Vegas. These typically fly at elevations from 10,000-15,000 feet MSL. There are limited general aviation flights over ISEGS (approximately one every hour). These pilots generally do not file flight plans with the FAA and typically fly at 5,000 feet MSL.

Staff contacted CCDOA staff on April 14, 2014, and was advised that, in conjunction with the FAA, CCDOA has the capability to generate air traffic data flight tracks over, or near, ISEGS. However, low-flying aircraft at increasing distances from the radar facility in Las Vegas do not track well. On April 30, 2014, CCDOA provided staff with information it had gathered using the Exelis Symphony Environmental Vue software application and the Exelis NextGen Surveillance Data regarding aircraft operations within 15 nautical miles (NM) of the ISEGS facility between January 1 and April 17, 2014 (CCDOA 2014b).[5] Major points from CCDOA data include:

- For the 76 days assessed, 29,757 aircraft operations passed within the 15 NM circle (or Point of Closest Approach), an average of 392 flights per day (24 hours).
- Altitudes captured varied from 1,225 feet MSL to 20,000 feet MSL (the maximum altitude captured by their radar feed).
- Approximately 47 percent of aircraft operations were arrivals heading towards the northeast, 43 percent were departures heading towards the southwest, and the remaining 10 percent were unknown or overflights.
- Approximately 76 percent of aircraft operations were originating at or departing from McCarran, 11 percent were Henderson Executive Airport operations, 3 percent were North Las Vegas Airport operations, and the remaining 12 percent were unassigned or overflights.

The maximum altitude captured by the radar feed was 20,000 feet MSL. The radar feed could not detect flight tracks at higher elevations. However, an FAA representative estimates a significant number of additional aircraft would utilize air corridors at the higher elevations (FAA 2014b).

[5] CCDOA provided this information as a courtesy and makes no warranty or other representation as to its accuracy.

Caltrans Aeronautics and Energy Commission staff flew down to ISEGS on May 8, 2014, in a single-engine Bonanza aircraft and took a variety of photographs and a video at different elevations from 13,000 to 5,000 feet MSL (CEC 2014a). Significant glare was generated by the ISEGS throughout an approximately 20-minute flight around the project beginning at 11:45 am. The brightest glare was generated by the stand-by mirrors located near power tower units 1 and 3. (Unit 2 was not operating at the time and was not producing any glare.) The Caltrans pilot said he would not look at the glare for more than a second because it would interfere with flying the aircraft in a safe and appropriate manner. In a subsequent e-mail to Energy Commission staff, he provided feedback as to what he experienced from flying in the vicinity of the ISEGS. He indicated that this was the brightest, most extensive amount of glare he had seen in his aviation career – and he has been flying since 1986. He had to shield his eyes with his hand while scanning for aircraft traffic while we flew eastbound on V-394 near the IESGS site from the nearest waypoint (CLARR intersection) at 13,500 feet MSL. The fact that ISEGS is located below and adjacent to heavily travelled airways definitely compounds the problem (Caltrans 2014b).

Staff's glint and glare consultant submitted a report after participating in the air flight over ISEGS which included the following observations (CEC 2014b):

1) Substantial intermittent and sustained levels of glare occur in airspace above the ISEGS;

2) The greatest glare levels are sustained (often for many seconds) and appear to be generated by DSRH events from heliostats in the "standby position." The number of heliostats simultaneously producing DSRH events is not known but it is substantial and certainly varies with respect to the particular airspace, time of day, and operation of the power tower. Staff believes that glare events could occur throughout the local airspace at various times of the day;

3) DSRH events from multiple heliostats in the standby position are sufficient to result in disability glare, compromise visual performance, and jeopardize flight safety as reported by pilots in complaints to CCDOA and NASA;

4) A significant percentage of the heliostats, 10-15 percent, appear to be out of alignment from the defined standard positioning schemes. An apparent consequence of this is frequent "rogue" individual DSRH events coming from seemingly random field locations. Although suboptimal and visually distracting, individual DSRH events are not considered unacceptable levels of glint and glare;

5) The sustained glare from the tower boiler-receivers is at acceptable levels for pilots; and

6) The sustained glare from multiple heliostats (often many hundreds) with a line of sight in proximity to the towers (i.e., heliostats reflecting the sky in close proximity to the sun) is at acceptable levels.

ACTION BY THE FAA

On April 22, 2014, the FAA issued the following Letter to Airmen regarding ISEGS glare:

> Recently the Ivanpah Solar Electric Generating System at Ivanpah Dry Lake, CA (LAS189036-LAS193034) has commenced generating electricity. This plant covers approximately 3,500 acres west of Interstate Highway 15 near the California-Nevada State Line with roughly 175,000 mirrors surrounding three collection towers. These towers employ a new technology that has not been utilized at this level before. Beginning in August 2013, as the facility neared completion, Las Vegas Terminal Radar Approach Control (TRACON) and Los Angeles Air Route Traffic Control Center (ARTCC) began receiving numerous pilot reports of glare associated with the power plant. Since December 2013, when the facility began production, more reports have surfaced. To appropriately document these conditions, pilots and other air crew members are urged to utilize NASA's Aviation Safety Reporting System (ASRS) and provide an Electronic Report Submission (ERS) via the web at http://asrs.arc.nasa.gov/report/electronic.html (FAA 2014a).

On June 10, 2014, the FAA provided staff an aeronautical study for ISEGS (FAA 2014c). The study provided flight information within a 15 nautical mile radius of the ISEGS site using the Performance Data Analysis and Reporting System and air traffic information from the Los Angeles Air Route Traffic Control Center. During May 2014, 11,969 aircraft tracks were detected from surface (ground) to 50,000 feet MSL. The study also included tables showing the departure and arrival airports of the aircraft involved as well as the type of aircraft and the time of day. Key observations from the study are:

- Greatest frequency of flights were between 10,000 to 20,000 feet MSL;
- Heaviest departure airport demand was Las Vegas and Los Angeles;
- Heaviest arrival airport demand was Las Vegas and Los Angeles;
- Flights occurred most frequently between 9 am and 4 pm, although they occurred throughout the day as well; and
- The majority of flights were commercial jets with 70 passenger seats or more.

The FAA study provides a more complete picture of the heavily used airspace in the ISEGS area and identifies the large number of pilots, flight crew and passengers that could be exposed to significant glare from the solar power tower facility.

The FAA also provided staff a recommendation document that was presented to an aeronautical charting forum regarding solar energy power plant construction. Recommendations included defining and establishing aeronautical charting symbols for large solar power plant sites such as ISEGS that will identify the visual landmark for

VFR navigational purposes, and note the site has potential ocular hazard considerations. ISEGS has been identified on the Los Angeles Sectional Aeronautical Chart but a recommendation to provide an ocular hazard symbol has been tabled awaiting more information (FAA 2014d).

STAFF CONCLUSIONS AND RECOMMENDATIONS

As discussed above, the September 2010 Energy Commission Decision in the ISEGS proceeding, noted that the FAA reviewed the seven originally proposed power towers and found no hazards to air navigation. The FAA did not address the issue of glare. The discussion of glare in the ISEGS Decision based on information available at the time led to the conclusion that aviators flying more than 1,000 meters (3,280 feet) above the project would not be in danger and could simply look away from the facility (CEC 2010). Because aircraft would be permitted to fly as low as 411 meters, the Energy Commission adopted Condition of Certification TRANS-3 requiring preparation of an HPP to avoid potential for human health and safety hazards from glare.

Staff recognizes that there have only been a small number of complaints filed compared to the large number of flights occurring in the vicinity of the ISEGS project. However, as noted earlier, one of the complaints noted that when the crew reported the event to Air Traffic Control, the response was “Yes, we get lots of complaints.” Another pilot noted flying this route several times a week and experiencing these hazards every time the sun is visible. Given these reports from pilots about significant and blinding glare from the ISEGS, which they consider to be a hazard to flight, staff believes it is time for the project owner to request that the FAA update a hazard determination to navigable airspace above the project area. The FAA official responsible for issuing a ‘No Hazard’ determination has the delegated authority to revise or terminate the determination provided, based on new facts that change the basis on which the original determination was made. Should the FAA issue a determination that the glare generated by ISEGS is a hazard to navigable airspace, more pilots would be aware of the potential hazard. The Letter to Airmen issued in April 2014, noted pilots have reported glare from ISEGS but did not declare it a hazard to navigable airspace. Staff understands that the FAA’s role is limited to evaluating the aeronautical effects of proposed or existing structures; the FAA has no legal authority to stop the construction or operation of any structure. This is the responsibility of local governments with jurisdiction to plan and control development (FAA 2012).

Further, a recent Airport Cooperative Research Report (ACRP) sponsored by the FAA discussed glare in the context of energy technologies and aviation safety impacts (ACRP 2014). It noted that solar power projects with a high concentration of mirrors have a greater potential for producing glare and specular reflection (glint), resulting in concern that glare from these types of projects could cause a momentary visual impairment to air traffic controllers or pilots depending on the location of the solar project. As noted above, one pilot complaint said the glare exposure from ISEGS lasted about 5 minutes. The ACRP report noted that while most problems related to glare from direct sunlight are predictable, occurring during the mornings and evenings when the

sun is close to the horizon, solar glare caused by reflections from solar energy installations can occur at varying times in unexpected locations (ACRP 2014).
Staff generally agrees with the most recent report from Dr. Ho regarding the July 22, 2014, ISEGS flyover, noting a need to consider additional standby aiming strategies and taking the next steps required to eliminate significant DSRH events. Based on the information reviewed to date, and the investigation discussed above, staff concludes that the current operation of ISEGS continues to generate disability glare that significantly impacts pilots flying in the general area, and is an aviation hazard to local airspace. Implementation of the recommendations listed below, are likely to reduce glare impacts to less than significant levels.

Staff recommends the following actions to address and mitigate significant disability glare to less than significant levels:

1. Energy Commission and BLM staff will convene a meeting in January 2015 with Solar Partners and all concerned agencies to consider the recommendations presented in the investigation reports.

2. Energy Commission staff will continue to work closely with NASA to timely receive and evaluate new complaint updates from the ASRS.

3. Prior to the January 2015 meeting, Solar Partners should provide a report on the status of implementing any of the next steps identified in the August 29, 2014, report, regarding the ISEGS July 22, 2014 flyover. The report should promptly be sent to all parties identified in the CCDOA March 10, 2014 letter.

4. Following the January 2015 agency meeting, Solar Partners should submit to the Energy Commission an updated draft HPP for approval. The draft HPP must incorporate the information identified in the NRG and Energy Commission staff glare investigations.

5. In preparing the HPP, Solar Partners will consult with Energy Commission staff on engineering modifications it plans to use to reduce significant glare, such as minimizing the number of mirrors in the standby position, implementing an improved calibration algorithm requiring a reduced range of motion (less beam repositioning) from its designated pointing direction to recalibrate each heliostat, and changing the geometry of the beam standby ring to reduce the potential for heliostat beams to overlap at locations in airspace beyond the heliostat field, and providing a means to block standby heliostat beams not pointed onto the receiver from exiting the heliostat field by providing a physical feature to act as a “light dump” or “glare shield” to intercept them and prevent them projecting into surrounding airspace.

6. Solar Partners should promptly file a new Form 7460-1 with the FAA and request an updated hazard determination to advise pilots about the potential for ISEGS to generate significant glare.

7. Solar Partners should work with the FAA to put a hazard symbol and remark on the next edition of the Los Angeles Sectional Chart noting the ISEGS generates significant glare and alerting pilots of the hazard.

REFERENCES

ACRP 2014 – Airport Cooperative Research Program Report 108, *Guidebook for Energy Facilities Compatibility with Airports and Airspace*, Transportation Research Board of the National Academies, sponsored by the Federal Aviation Administration, 2014. http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_108.pdf

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CCDOA 2014a – Clark County Department of Aviation, Letter from Teresa R. Motley, Airport Planning Manager, Las Vegas McCarran International Airport, to Raymond C. Lee, Field Manager, Bureau of Land Management, Joseph Douglas, Compliance Project Manager, California Energy Commission, and Jennifer Wallens, BrightSource Energy, Inc., dated March 10, 2014. http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN201847_20140310T145948_ISEGS_Pilot_Visual_Complaint.pdf

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CEC 2014a – Photographs taken during the overflight of the ISEGS on May 8, 2014.

CEC 2014b – *A Flyover of the Ivanpah Solar Electric Generating System (ISEGS) – Observations Regarding Glare*, report submitted by Gregg Irvin, dated May 28, 2014 (Exhibit 1).

FAA 2012 – Order JO 7400.2J, *Procedures for Handling Airspace Matters*, Section 3. Revision, Correction, Termination of Determination, 7-3-1. Revisions and Terminations Based on New Facts, Effective Date: February 9, 2012.

FAA 2014a - E-mail from Rex MacLean, FAA Western Service Center Operations Support Group, with attached Letter to Airmen regarding ISEGS to James Adams on April 30, 2014.

FAA 2014b - E-mail from Rex MacLean to James Adams on May 5, 2014.

FAA 2014c - E-mail from Dan Rollins with attached Ivanpah Solar Project Aeronautical Study to James Adams on June 10, 2014.

FAA 2014d – E-mail from Rex MacLean to James Adams on November 7, 2014 regarding update on Recommendation Document to the Aeronautical Charting Group.

NASA ASRS 2014a – E-mail from Linda Connell to James Adams on April 9, 2014.

NASA ASRS 2014b – E-mail from Linda Connell to James Adams on September 2, 2014.

NASA ASRS 2014c – E-mail from Linda Connell to James Adams on October 17, 2014.

NRG 2014a – NRG Energy, Letter from Shankara Babu, Energy Services Manager, to Teresa R. Motley, dated March 20, 2014. http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN201915_20140325T103225_Ivanpah_Solar_Electric_Generating_System_response_to_Clark_Coun.pdf

NRG 2014b – NRG Energy, Letter from Shankara Babu to Joseph Douglas, dated March 28, 2014.

NRG 2014c – NRG Energy, Letter from Shankara Babu to Joseph Douglas, dated April 29, 2014.

Sandia 2014a – Sandia National Laboratories, *Evaluation of Glare at the Ivanpah Solar Electric Generating System*, Printed July 2014. http://docketpublic.energy.ca.gov/PublicDocuments/07-AFC-05C/TN202718_20140717T110103_Ivanpah_SEGS_Heliostat_Positioning_Plan_Report.pdf

Sandia 2014b – E-mail from Cliff Ho to James Adams on July 25, 2014.

Sandia 2014c – Sandia National Laboratories, *Evaluation of Glare at the Ivanpah Solar Electric Generating System – 2nd Flyover on July 22, 2014*, sent by e-mail from Cliff Ho to James Adams on August 29, 2014.

ATTACHMENTS

CALIFORNIA ENERGY COMMISSION

REPORT OF CONVERSATION

Energy Facilities Siting and Environmental Protection Division

FILE:07-AFC-05C

PROJECT TITLE: Ivanpah Solar Electric Generating System (ISEGS)

☒ **Telephone**	702-261-5510	☐ **Meeting Location:**		
NAME:	Gary Cathey	**DATE:** 4/28/14	**TIME:**	2:45 PM
WITH:	California Department of Transportation – Division of Aeronautics, Chief			
SUBJECT:	Pilots experiencing glare from ISEGS			

COMMENTS: I called Mr. Cathey to talk about flying down to ISEGS to photograph and instances of glare. The first week of May looks doable. He confirmed that most of the high altitude aircraft using the air corridors above/near ISEGS are between 30-36,000 feet MSL.

cc:	**Signed:**
	Name: James Adams 4/25/14

ATTACHMENT 1

Douglas, Josepht@Energy

From: Adams, Jim@Energy
Sent Friday, May 09, 20142:26 PM
To: Marxen, Chris@Energy
Cc: Flores, David@Energy; Douglas, Joseph@Energy
Subject: FW: Ivanpah Solar Power Plant site Recon
Attachments: CLARR Two Arrival to LAS.pdf CRESO Three STAR.pdf

Box 1f

From: Cathey, Gary C@DOT
Sent: Friday, May 09, 20142:13 PM
To: Adams, Jim@Energy
cc: Brown, *Jeff R@DOT*; Crimmins Phillip P@DOT
Subject: Ivanpah Solar Power Plant site Recon

Jim,

Attached is an updated Itinerary (rounded to the nearest 15 minutes), based on our trip yesterday:

0745-0815	**Preflight N20CA, load & go**
0815-1030	**Fly SAC - Apple Valley Airport (APV)**
1030-1100	**Refuel / Quick break**
1100-1145	**Fly APV-CLARR**
1145-1215	**Recon Ivanpah Power Plant (IPP) site**
1215-1300	**IPP-CLARR-APV**
1300-1345	**Lunch @APV, refuel**
1345-1600	**Fly APV-SAC**
1600-1630	**Postflight, refuel, unload & go**

I hope your photos and videos of IPP turn out well. I must say flying In the vicinity of the IPP facility generated the brightest, most extensive amount of glare that I've seen in my aviation career - and I have been flying since 1986. As you may have noticed, I had to shield my eyes with my hand as I was scanning for aircraft traffic while we flew eastbound on V-394 to the IPP site from the nearest waypoint (CLARR Intersection). CLARR is part of the Standard Terminal Arrival (STAR) CLARR Two Arrival procedure to Mc Carran International Airport (LAS), North Las Vegas Airport (VST), Henderson Executive Airport (HND), and Boulder City Municipal Airport (BVU) in or near Las Vegas, NV. Similarly, the CRESO Three STAR to LAS routes arriving aircraft directly over the IPP site at 12,000' MSL on V 21-283 / V-587 at WHIGG waypoint. Standard Departure Procedures (DPs) also require aircraft departing LAS and surrounding airports to fly towards the IPP site. LAS has 9 STARs and 9 DPs that frequently channel aircraft west of Las Vegas – to or from the vicinity of the IPP site.

I attached a copy of the CLARR Two and CRESO Three STARs for your reference. I look forward to staying in touch with you and learning more about the proposed mitigation measures that will be recommended to minimize the amount of glare generated by IPP. The fact that it is located below and adjacent to heavily travelled airways definitely compounds the problem. I sincerely hope that if similar facilities are proposed in the future, the CEC will consider the "lessons learned" from the construction of this facility at this location to alleviate problems of similar magnitude at other locations.

Respectfully,

Gary

Adams, Jim@Energy

From: Teresa Motley [teresamo@mccarran torn]
Sent: Wednesday, April 30, 2014 9:34 AM
To: Adams, Jim@Energy
Cc: E Thomson; Mark Silverstein; Jeffrey Jacquart; Charles Hall; Saeed Bonabian
Subject: ISEGS overflight request
Attachments: Solar Farm PCA.jpg

Good Morning Mr. Adams:

Per your request, the Clark County Department of Aviation (CCDOA) is providing the information it has gathered using the Exelis Symphony EnvironmentalVue software application and the Exelis NextGen Surveillance Data, regarding aircraft operations within 15 nautical miles of the Ivanpah Solar Electric Generating System (ISEGS) facility between January 1 and April 17, 2014.

CLARK COUNTY DEPARTMENT OF AVIATION IS PROVIDING THIS INFORMATION AS A COURTESY AND MAKES NO WARRANTY OR OTHER REPRESENTATION AS TO ITS ACCURACY. PLEASE NOTE THAT THE SURVEILLANCE DATA FROM WHICH THE INFORMATION BELOW WAS GATHERED IS USED BY THE CLARK COUNTY DEPARTMENT OF AVIATION FOR MODELING PURPOSES ONLY AND IS NOT INTENDED TO REPRESENT A COMPLETE AND ACCURATE RECORD OF FLIGHTS IN THE AREA OF INQUIRY. THE SURVEILLANCE DATA EXCLUDES FLIGHTS ABOVE 20,000 FEET ABOVE MEAN SEA LEVEL, AND LIKELY DOES NOT REFLECT MANY LOW-FLYING FLIGHTS WITHIN THE AREA DUE TO THE SHIELDING EFFECTS CAUSED BY MOUNTAIN RANGES BETWEEN LAS AND ISEGS. THERE IS NO GUARANTEE THAT THE INFORMATION INCLUDES ALL FLIGHTS OR THE LOCATION OF PARTICULAR FLIGHTS AT ANY ELEVATION. THE DATA PROVIDED SHOULD BE USED FOR GENERAL INFORMATIONAL PURPOSES ONLY AND SHOULD NOT BE RELEASED TO OTHER PARTIES IN ANY FORM WITHOUT CLEARLY INDICATING THIS DISCLAIMER.

CCDOA was able to derive the following flight analysis for aircraft operations within 15 nautical miles (NM) of the ISEGS, between January 1 and April 17, 2014. Note that the Surveillance Data ends at a 40 nautical mile arc from McCarran International Airport (LAS). [See attached jpeg for 15 NM circle and extent of radar data.] It should also be noted that partial tracks [also known as broken tracks] occur this far from LAS.

1) For the 76 days assessed, 29,757 operations passed within the 15 NM circle (or Point of Closest Approach), an average of 392 flights per day.

2) Altitudes captured varied from 1,225' above mean sea level (AMSL) to 20,000' AMSL (the maximum altitude captured by our radar feed).

3) Approximately 47% were arrivals heading towards the northeast, 43% were departures heading towards the southwest, and the remaining 10% unknown or overflights.

4) Approximately 76% were operations originating at or departing from LAS; 11% Henderson Executive Airport operations, 3% North Las Vegas Airport operations, and the remaining 12% unassigned or overflights.

5) Approximately 53% of all operations were likely aircraft which weigh more than 75,000 pounds (or large passenger/cargo aircraft) and the remaining 47% were likely aircraft which weigh less than 75,000 pounds.

6) The average altitude through the 15 NM circle for aircraft greater than 75,000 pounds assigned as an arrival was approximately 12,700' AMSL while the average departure altitude was approximately 16,200' AMSL.

7) The average altitude through the 15 NM circle for aircraft less than 75,000 pounds assigned as an arrival was approximately 12,100' AMSL while the departure average altitude was approximately 16,800' AMSL.

ATTACHMENT 3

If you have any questions regarding this information, please call Jeff Jacquart, Airport Program Administrator, at (702) 261-5510.

Thank you,

Teresa Motley

Teresa R. Motley, AICP
Airport Planning Manager Clark County Department of Aviation
P.O. Box 11005
Las Vegas, NV 89111-1005
(702) 261-5706 (Office)
(702) 249-0365 (cell)

(702) 798-6591 (FAX)

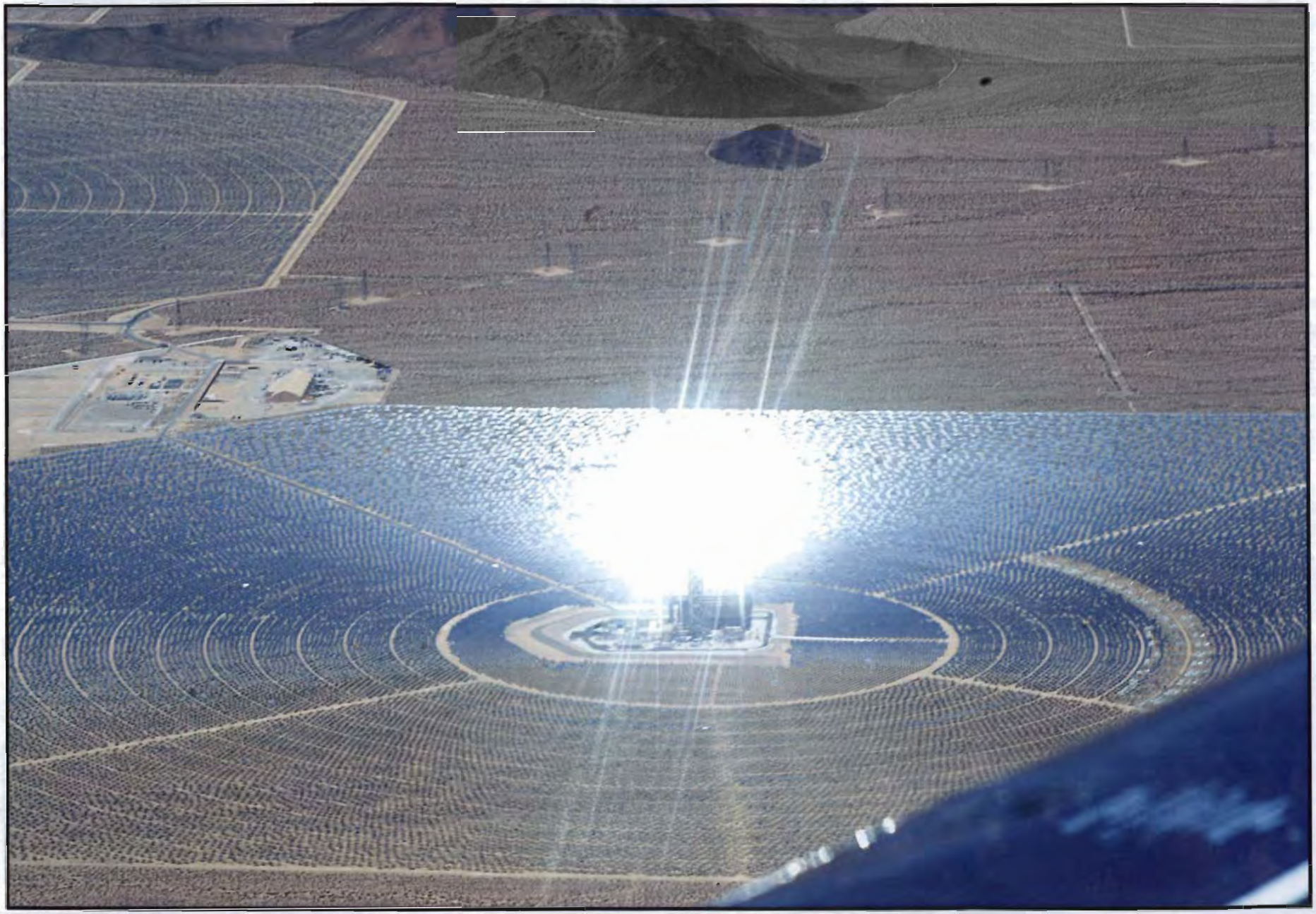
ATTACHMENT 3

TRAFFIC & TRANSPORTATION - FIGURE 1
Ivanpah Solar Electric Generating System - Overflight of Ivanpah

CALIFORNIA ENERGY COMMISSION, SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION
SOURCE: Aircraft Photo Taken During CEC Staff's Overflight on May 8, 2014

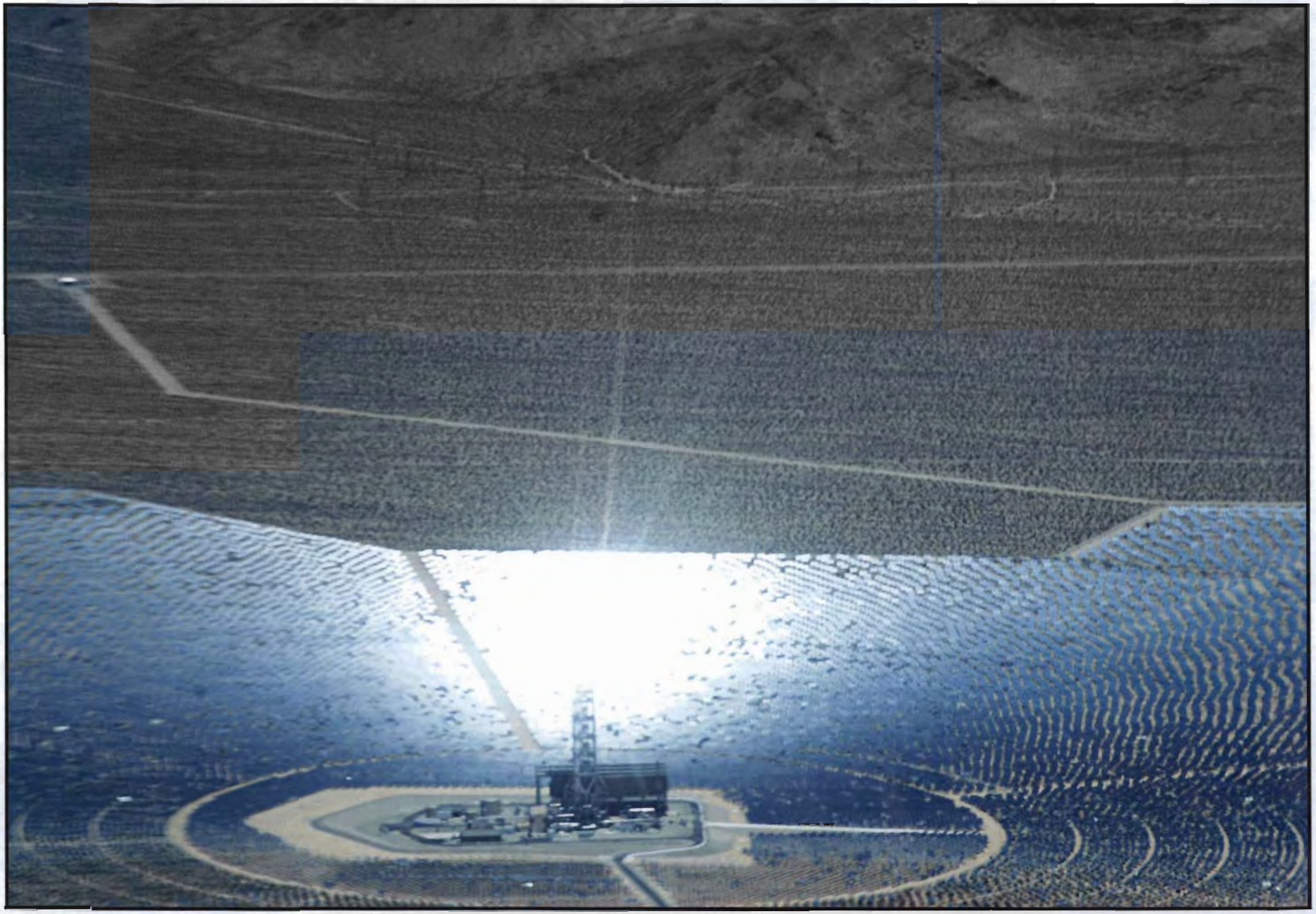
ATTACHMENT 4

TRAFFIC & TRANSPORTATION - FIGURE 2
Ivanpah Solar Electric Generating System - Overflight of Ivanpah



CALIFORNIA ENERGY COMMISSION, SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION
SOURCE: Aircraft Photo Taken During CEC Staff's Overflight on May 8, 2014

TRAFFIC & TRANSPORTATION - FIGURE 3
Ivanpah Solar Electric Generating System - Overflight of Ivanpah



CALIFORNIA ENERGY COMMISSION, SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION
SOURCE: Aircraft Photo Taken During CEC Staff's Overflight on May 8, 2014

A Flyover of the Ivanpah Solar Electric Generating System (ISEGS) Observations Regarding Glare

The Ivanpah Solar Electric Generating System (ISEGS) at Ivanpah Dry Lake, CA covers approximately 3,500 acres west of Interstate Highway 15, six miles south of the California-Nevada State Line, with roughly 175,000 minors surrounding three collection towers. Beginning in August 2013, as the facility neared completion of construction, the Las Vegas Terminal Radar Approach Control (TRACON) and Los Angeles Air Route Traffic Control Center (ARTCC) began receiving numerous pilot reports of glare associated with the power plant. Since the facility began power generation operations in December 2013, there have been more reports of airborne glare effects.

To obtain an estimate of the number of flights in the vicinity of ISEGS, the Clark County Department of Aviation (CCDOA) provided information regarding aircraft operations within 15 nautical miles (NM) of the ISEGS facility between January I and April 17, 2014. For the 76 days assessed, 29,757 operations passed within 15 NM of ISEGS, an average of 392 flights per day. The altitude data captured varied from 1,225 feet mean sea level (MSL) to 20,000 feet MSL, the maximum altitude that the radar systems were capable of detecting. A Federal Aviation Administration representative has advised California Energy Commission staff that a significant number of flights occur at altitudes greater than 20,000 feet MSL. From this data, it is apparent that the airspace over ISEGS is used heavily, making it especially important to assess any glare effects from ISEGS.

Energy Commission and Caltrans Aeronautics staff decided to conduct an overflight of the ISEGS facility to perform empirical observations of glint and glare and to videotape and photograph any such effects. Staff planned the flight to replicate the experience of a pilot who encountered and reported severe glare in March 2014 at the same location and flight trajectory. A portion of the report (CAN: 1156120) is provided below for context.

> *Narrative: 1*
>
> *While on the KEPEC3 arrival into LAS (McCarron International Airport in Los Vegas) we were temporary blinded by bright lights (reflections) from the ground. These reflections, coming from the new solar power station, were so bright that any attempt to look outside the plane was met with pain and temporary blindness even when looking back inside. Any attempt to see and avoid was useless and trying to find the airport during this time was painful as well. Exposure lasted about 5 minutes. We notified ATC (air traffic control) and were told that they get a lot of complaints about these reflections.*
>
> *Callback: 1*
>
> *The reporter stated that he was in the left seat and viewed the mirror reflections for only seconds, then was able to get his head sheltered below the glareshield and away from the light. However, even after the brief exposure, he had blue dots in his vision for about 5 minutes. The First Officer had no way to avoid the light even while not looking directly at it. The First Officer was literally blind for more than five minutes, and neither pilot's*

vision was capable of detecting objects outside of the cockpit for a period of time. When the crew reported the event to ATC, the response was "Yes, we get lots of complaints".

On May 8, 2014, Gary Cathey, Caltrans Aeronautics Division Chief, Jim Adams, Environmental Planner with the Energy Commission, and Gregg Irvin, glint and glare consultant with the Energy Commission, departed from Sacramento on a 4-seat, single-engine Bonanza aircraft to observe ISEGS from the air. The initial approach to ISEGS was from the west at an altitude of 13,000 feet MSL with arrival at the initial CLARR waypoint 13 miles northwest of ISEGS. Upon arriving at CLARR at approximately 11:45 AM, the ISEGS facility came into view as it was unmasked by the Clark and Mesquite mountains. Visibility was unlimited (greater than 30 miles). Staff began videotaping and photographing ISEGS at this point. Photo 1 shows the view of ISEGS from the CLARR waypoint.

All three observers were surprised by the level of brightness and glare they experienced. At this point the pilot, Mr. Cathey, commented that the glare was too excessive for him and that he would no longer look in the direction of the ISEGS for the remainder of the overflight. He stated that he would focus on flying the plane while Mr. Adams and Mr. Irvin observed the ISEGS and directed him which way to turn and which altitudes to assume so that they could better observe the plant's glint and glare effects. The flight around the ISEGS took approximately 20 minutes.

Photo 1. *Arrival at CLARR waypoint at an altitude of 13,000 feet, 13 miles west of the ISEGS. The photo was taken from the west. From left to right: Tower 1 (in the center of the photo); and Tower 2, which was not operating during the flight. Tower 3 is just out of the picture to the right.*

It is important for the reader to note that photographic documentation cannot possibly capture the subjective experience of brightness and glare experienced in-person. The photographic image

can only be as bright as this sheet of paper. However, the photographs (and video documentation) are very instructive and do provide a reasonable substitute for viewing the plant in-person.

Photo 2 shows all three towers when viewed at a distance of approximately 11 to 12 miles to the north at an altitude of approximately 11,000 to 12,000 feet MSL. The amount of glare from the different towers' heliostat fields differs depending on the photographer's position relative to the heliostats. For example, the viewpoint to Tower 1 is just outside of the direct solar reflections from the heliostats (DSRH) produced by Tower 1's heliostats in the standby position. The periphery of Tower 1's heliostat field reflects the blue sky while the heliostats closer in visual alignment with the tower produce brighter reflections, as these heliostats are reflecting the brighter sky region in closer proximity to the sun. However, no DSRH are visible as none of the heliostats are directly reflecting the sun at the observer. The tower itself has its standard glow and the ring of reflections produced by heliostats in the standby position (standby ring) is not visible. In general, this is a situation not producing disability glare. A variety of bright individual heliostats can be seen which are apparently out of alignment, with one (to the right of the tower) very close to producing a DSRH event.

However, as shown in Photo 2, the photographer is situated so that Tower 3's standby ring is visible, with the heliostats flanking the left and right side of the tower producing exceptionally bright DSRH events in a steady state manner. The position of the photographer in relation to the position and orientation of the heliostats results in disability glare to the viewer. Although the standby ring circumscribes the tower (much like a doughnut shape with the tower as the hole in the middle) it appears that the glare is emanating from the left and right portions of the ring. This is because the line of sight through the ring (the doughnut) has the greatest density on the sides and the greatest number of heliostats producing DSRH events. The glare from the tower under these conditions is overwhelmed by the standby ring brightness and often is not even visible through the standby ring glare.

Photo 2. *Photo of the ISEGS site taken from the north. From left to right: Tower 1; Tower 2, not in operation; and Tower 3. The photographer's position in relation to heliostat position and orientation results in no DSRH from Tower 1, but strong DSRH from Tower 3 which causes disability glare.*

After staff took the above photographs, the aircraft made a gradual decent while making a single clockwise circle around the ISEGS facility. Turbulence in and around the towers was quite extensive, making photographic and video documentation difficult. During the remainder of the flyover, at altitudes from 5,000 to 10,000 MSL and distances from 2-3 to 10 miles from ISEGS, the frequency of large DSRH events from the standby rings was extensive. During these DSRH events, the standby rings were extremely bright at all air flight distances, and all three observers agreed that these levels of brightness and sustained glare clearly constituted a disability glare level. While filming the ISEGS with a high-band 8 mm camera, Mr. Irvin noted that he could no longer see the image on the display because his vision was so compromised. He also could no longer see the text on the camera display, so he was uncertain if he was still recording, and the visibility of the display image was so compromised that he could not tell if he was accurately pointing the camera. This disability glare condition lasted during the entire flyover. Afterimages produced by the glare were prominent, central vision was noticeably compromised from observing the glare, and at times the glare field was actually painful.

As staff circled the ISEGS heliostat field, they found that the glare from certain angles was acceptable. An example of this is shown in Photo 3, where the line of sight to the tower is outside of the standby ring projection. The glow of the tower receiver together with the heliostats' reflections of the sky in proximity to the sun is at acceptable levels and is not producing any DSRH event. Note that there are a number of heliostats that appear to be in unique

positions, perhaps out of alignment. Also, there is a band of heliostats in some other position, perhaps in stow, a cleaning position, or simply off-line.

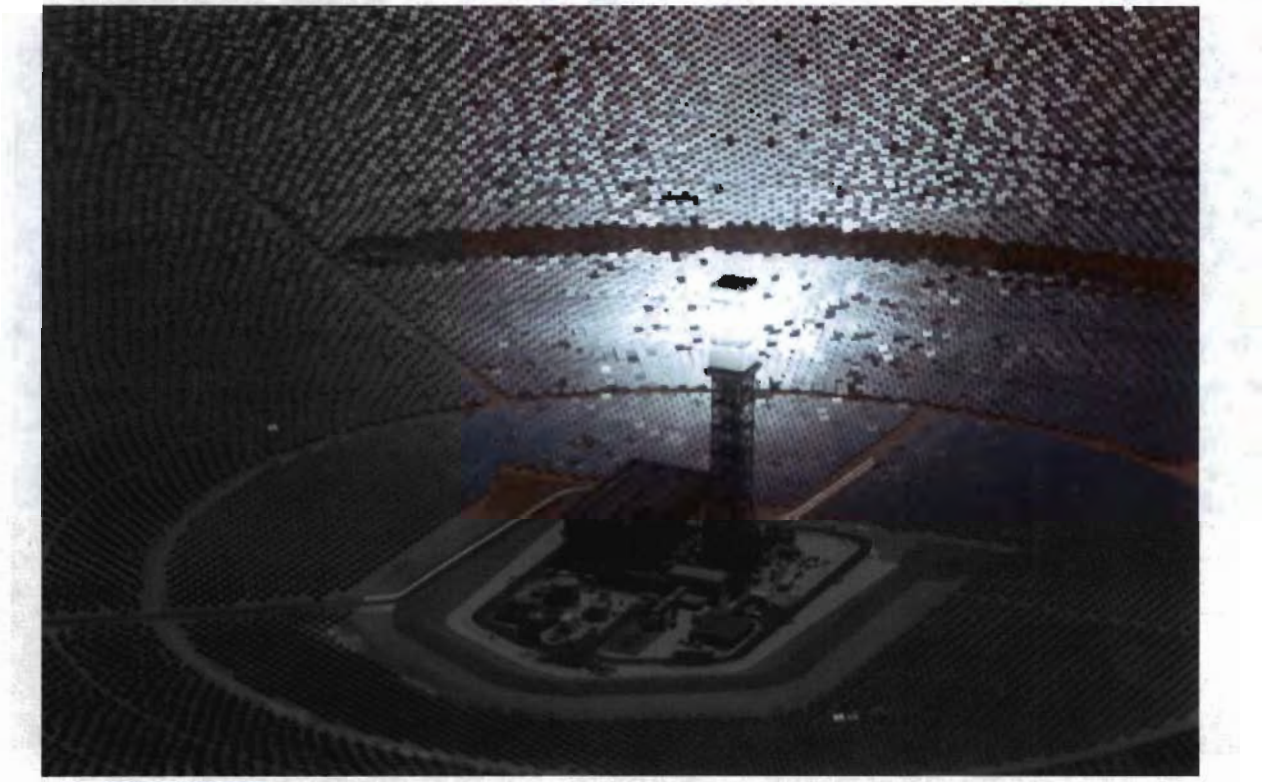


Photo 3. (ISEGS) *Example of line of sight geometry to Tower 3 outside of the DSRH projections of the standby ring. The photo was taken from the west.*

In addition to the extreme glare from the standby rings, staff experienced frequent individual DSRH events from single heliostats. These events occurred as the aircraft flew through the reflected glare 'beam' of a heliostat, and each event lasted between 1 and 5 seconds. Although individual DSRH events were common and the brightness of an individual DSRH event was quite high, staff did not consider DSRH from single heliostats as sufficiently bright or extended in duration to result in disability glare. Also, individual DSRH events appeared to be coming from heliostats that were clearly out of a set alignment position. Staff estimated that approximately 10-15% of the heliostats appeared to be in random orientations.

Photo 4 provides several examples of glare within and at the margins of the DSRH projection field of the heliostats in the standby rings. More photos of ISEGS and a video of the flyover are available for review upon request.

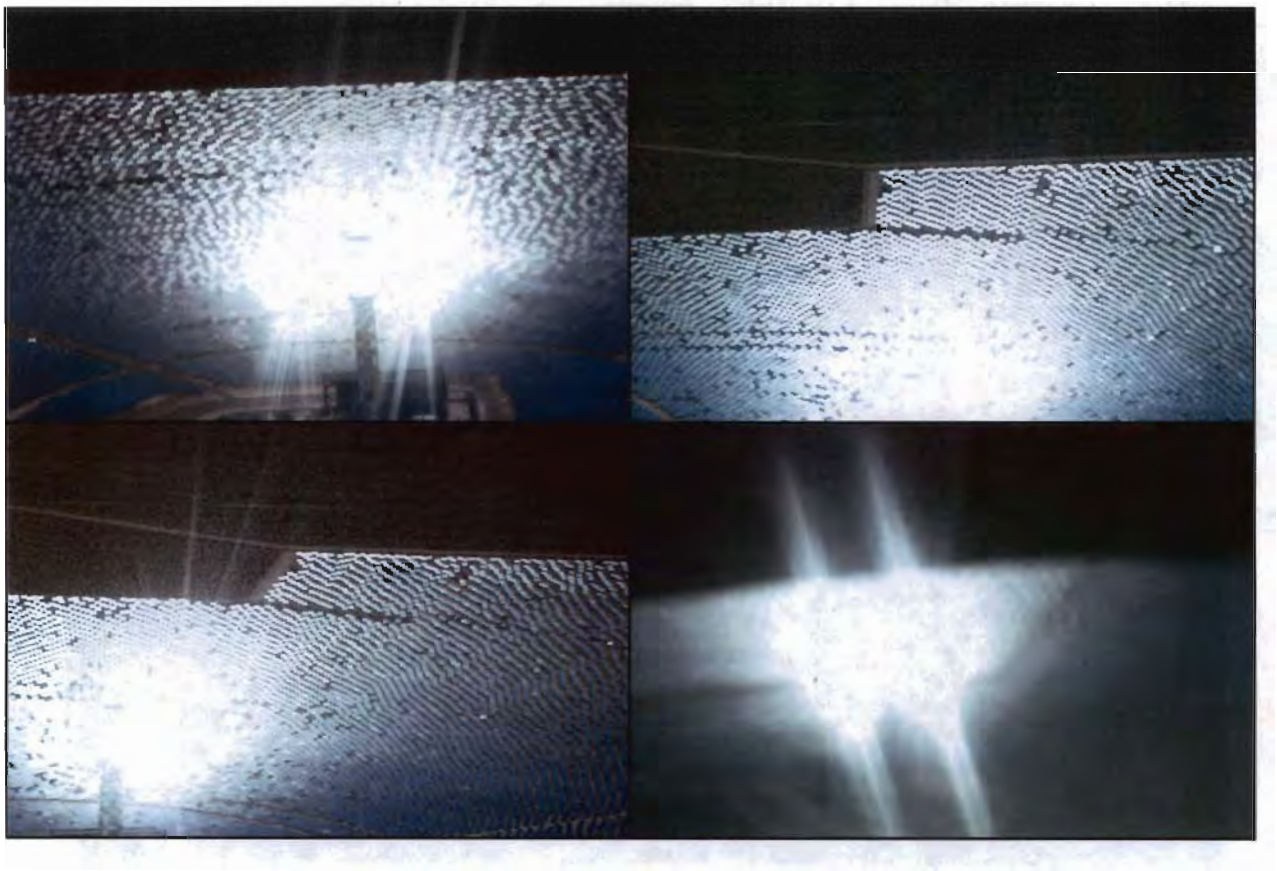


Photo 4. *Several glare examples from a variety of positions within and at the boundaries of the DSRH projection field of the heliostats in the standby rings. Lack of good focus due to pronounced turbulence.*

In summary, during normal ISEGS power operations, there are large volumes of airspace in which a passing aircraft can experience elevated levels of glare sufficient to disrupt pilot performance. Although the full impact on airborne operations and the extent of the airspace volume in which these levels of glare occur is unknown, it is clear that the glare experienced during overflight is significant. Of particular note are the following observations:

1) Substantial intermittent and sustained levels of glare occur over a wide range of airspace.
2) The greatest glare levels are sustained (often for many seconds) and appear to be generated from DSRH events from heliostats in the standby position. The number of heliostats simultaneously producing DSRH events in the standby position is not known, but it is substantial and certainly varies with respect to the particular airborne geometry and time of day. Staff believes that glare events could be worse during mid-morning or mid-afternoon when the sun is at a 45° angle in the sky instead of being directly overhead as it was during the May 8 overflight.
3) DSRH events resulting from multiple heliostats in the standby position are sufficient to result in disability glare and compromise visual performance, and are judged by pilots as being at levels that are unacceptable for flight safety.
4) A significant percentage of the heliostats, 10-15%, appear to be out of alignment from the defined standard positioning schemes. An apparent consequence of this is frequent

'rogue' individual DSRH events coming from seemingly random field locations. Although suboptimal and visually distracting, individual DSRH events are not considered as producing unacceptable levels of glint and glare.

5) The sustained glare from the tower receivers is at acceptable levels.
6) The sustained glare from multiple heliostats (often many hundreds) with a line of sight in proximity to the towers (i.e., heliostats reflecting the sky in close proximity to the sun, but not the sun itself) is at acceptable levels.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization Policy

ORDER
JO 7400.2J

Effective Date:
February 9, 2012

SUBJ: Procedures for Handling Airspace Matters

This order specifies procedures for use by all personnel in the joint administration of the airspace program. The guidance and procedures herein incorporate into one publication as many orders, notices, and directives of the affected services as possible. Although every effort has been made to prescribe complete procedures for the management of the different airspace programs, it is impossible to cover every circumstance. Therefore, when a situation arises for which there is no specific procedure covered in this order, personnel must exercise their best judgment.

The order consists of six parts:

a. Part 1 addresses general procedures applicable to airspace management.

b. Part 2 addresses policy and procedures unique to Objects Affecting Navigable Airspace.

c. Part 3 addresses policy and procedures unique to Airport Airspace Analysis.

d. Part 4 addresses policy and procedures unique to Terminal and En Route Airspace.

e. Part 5 addresses policy and procedures unique to Special Use Airspace.

f. Part 6 addresses policy and procedures regarding the integration of Outdoor Laser Operations, High Intensity Light Operations, and integration of Rocket and Launch-Vehicle Operations into the National Airspace System.

Elizabeth L. Ray
Vice President, Mission Support Services
Air Traffic Organization

Date: 12-16-11

Distribution: ZAT-740 (ALL)

Initiated By: AJV-0
Vice President, Mission Support Services

ATTACHMENT 6

Chapter 7. Determinations

Section 1. Issuing Determinations

7-1-1. POLICY

All known aeronautical facts revealed during the obstruction evaluation must be considered when issuing an official FAA determination. The determination must be a composite of all comments and findings received from interested FAA offices. Should there be a disagreement in the findings, the disagreement must be resolved before issuance of a determination. The basis for all determinations must be on the aeronautical study findings as to the extent of adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Evidence of adverse effect alone, either physical or electromagnetic, is not sufficient justification for a determination of hazard. However, a finding of a substantial physical or electromagnetic adverse effect normally requires issuance of a determination of hazard.

7-1-2. RESPONSIBILITY

a. Air traffic is responsible for issuing determinations.

b. If any division objects to a structure that does not exceed Part 77, and/or is not found to have a physical or electromagnetic radiation effect on the operation of air navigation facilities, an advisory statement may be submitted to OEG for inclusion in the determination. Examples would be:

1. Objections identifying potential airport hazards based on airport design criteria such as a structure within the runway protection zone (RPZ).

2. Objections identifying potential airport hazards such as structures which may not be above ground level (e.g., landfills, retention ponds, and waste recycling areas) but may create an environment that attracts birds and other wildlife.

7-1-3. DETERMINATIONS

Determinations issued by the FAA receive widespread public distribution and review. Therefore, it is essential that each determination issued is consistent in form and content to the extent practicable. To facilitate this and to achieve economy in clerical handling, automated correspondence is available through the OE/AAA automation program and must be used in lieu of previously approved FAA forms. Determinations must be issued as follows:

a. Issue a "Does Not Exceed" (automated DNE letter) determination if the structure does not exceed obstruction standards, does not have substantial adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities, and would not be a hazard to air navigation.

NOTE-
A determination indicating that No Notice is Required (NNR) is no longer authorized.

b. Issue an "Exceeds But Okay" (automated EBO letter) determination if the structure exceeds obstruction standards but does not result in a substantial adverse effect, circularization was not necessary, and meets one of the following conditions:

1. The structure is temporary;

2. The structure is existing; or

3. The structure involves an alteration with no physical increase in height or change of location such as a proposed decrease in height or proposed side mount.

NOTE-
The significant difference between an EBO determination and a "Determination of No Hazard to Air Navigation" (DNH) is that the EBO determination does not allow for petition rights.

c. Issue a "Notice of Presumed Hazard" (automated NPH letter) if the structure exceeds obstruction standards and/or has an adverse effect upon navigable airspace or air navigation facilities and resolution or further study is necessary to fully determine the extent of the adverse effect. The NPH facilitates negotiation and is useful in preserving navigable airspace. Normally, the FAA should not automatically initiate further study (including circularization) without a request to do so by the sponsor. The intent of the NPH is to inform the sponsor of the initial

Section 3. Revision, Correction, and Termination of Determination

7-3-1. REVISIONS AND TERMINATIONS BASED ON NEW FACTS

The FAA official responsible for issuing a no hazard determination has the delegated authority (Section 77.39) to revise or terminate the determination provided. The decision is based upon new facts that change the basis on which the original determination was made.

a. Revised determinations based on new aeronautical facts must be issued under a new aeronautical study number that would cancel and supersede the original determination.

b. A decision to terminate a no-hazard determination must be based on new facts that change the basis on which the determination was made. Normally in such a case, a subsequent "Determination of Hazard" would be issued under a new aeronautical study number.

c. If a proposed structure is relocated or there is a height change after a determination of no hazard is issued, a new filing must be submitted. When new filings are received, terminate any previous determinations before moving forward with the aeronautical studies. Multiple filings at the same location result in an administrative hardship and create a cumulative impact issue that could result in erroneous data analysis. Determinations must not be used as a basis for financial arrangements.

7-3-2. CORRECTION

The FAA official issuing a determination may also correct that determination as required. Editorial changes that do not involve a coordinate change (of one second or more in latitude or longitude) or elevation change (of one foot or more) may be issued as corrections. In this case, no change to dates would be necessary. Adjustments or corrections to a proposal that involve one or both of the above coordinate or elevation changes must be addressed as a new and separate obstruction evaluation study.

7-3-3. STANDARD FORMAT

a. A revised determination based on new aeronautical facts must follow the standard format of the appropriate determination. An explanation should be included addressing the reason for the revision. A statement indicating that the revised determination cancels and supersedes the determination originally issued, should also be included.

b. A determination addressing editorial changes that do not involve structure coordinates or elevations may be issued by duplicating the original determination, making the corrections, adding a statement explaining the correction, and adding "Corrected" at the end of the title.

c. A determination addressing corrections to coordinates or elevations must follow the standard format of the appropriate determination. An explanation should be included addressing the correction. This may be done in the description section of the determination. A statement should also be included which indicates that the corrected determination cancels and supersedes the original determination.

7-3-4. DISTRIBUTION

Copies of revised or corrected determinations must be given the same distribution as the original determination and, if appropriate, be distributed to other known interested persons or parties.

Marxen, Chris@Energy

From: Adams, Jim@Energy
Sent: Wednesday, April 30, 2014 1:43 PM
To: Marxen, Chris@Energy
Cc: Flores, David@Energy; Douglas, Joseph@Energy
Subject: FW: Ivanpah Info

Box 3a.

From: CONNELL, LINDA (ARC-TH) [mailto:linda.j.connell@nasa.gov]
Sent: Wednesday, April 30, 2014 1:40 PM
To: Adams, Jim@Energy
Subject: Re: Ivanpah Info

Jim
Very interesting, even WOW. This is complex concerning a potential solution.
Linda

From: <Adams>, "Jim@Energy" <Jim.Adams@energy.ca.gov>
Date: Wednesday, April 30, 2014 12:23 PM
To: Linda Connell <linda.j.connell@nasa.gov>
Subject: FW: Ivanpah Info

FYI

From: Rex.MacLean@faa.gov [mailto:Rex.MacLean@faa.gov]
Sent: Wednesday, April 30, 2014 10:08 AM
To: Jolda.Reed@faa.gov
Cc: Valerie.S.Watson@faa.gov; Adams, Jim@Energy; Alex.CTR.Rushton@faa.gov
Subject: Ivanpah Info

Jolda,

The attached email concerning the Ivanpah Concentrated Solar Power Plant may be of interest during the ACF activity concerning Solar Power Plants.

Additionally, the attached Las Vegas Approach Letter To Airmen (LTA) was published on April 22.

RX

Rex MacLean
Air Traffic Control Specialist
Western Service Center
Operations Support Group, AJV-W22
1601 Lind Avenue SW
Renton, WA 98057-3356

Office: (425) 203-4564
email: Rex.MacLean@faa.gov

Please contact the Northwest Mountain Regional Operations Center at (425) 227-2000 to be connected to the Tactical Operations Team 24-7 contact.

ATTACHMENT 7

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

Las Vegas TRACON
699 Wright Brothers Lane
Las Vegas, NV 89119

Issued: 04/22/2014 2206 (UTC)
Las Vegas TRACON

Effective: 05/05/2014 1200 (UTC)
Letter to Airmen: LTA-L30-3

Subject: Solar PowerPlant Glare

Cancellation: 05/04/2015 1200 (UTC)

Recently the Ivanpah Solar Electric Generating System at Ivanpah Dry Lake, CA (LAS189036-LAS193034) has commenced generating electricity. This plant covers approximately 3,500 acres west of Interstate Highway 15 near the California-Nevada State Line with roughly 175,000 mirrors surrounding each of three collection towers. These towers employ a new technology that has not been utilized at this level before.

Beginning in August 2013, as the facility neared completion, Las Vegas Terminal Radar Approach Control (TRACON) and Los Angeles Air Route Traffic Control Center (ARTCC) began receiving numerous pilot reports of glare associated with the power plant. Since December 2013, when the facility began production, more reports have surfaced.

To appropriately document these conditions, Pilots and other air crew members are urged to utilize NASA's Aviation Safety Reporting System (ASRS) and provide an Electronic Report Submission (ERS) via the web at http://asrs.arc.nasa.gov/report/electronic.html

John Howard
Air Traffic Manager, Las Vegas TRACON

Marxen, Chris@Energy

From: Adams, Jim@Energy
Sent: Monday, May 05, 2014 10:50 AM
To: Marxen, Chris@Energy
Cc: Flores, David@Energy; Douglas, Joseph@Energy
Subject: FW: Ivanpah Info

Box 2b.

From: Rex.MacLean@faa.gov [mailto:Rex.MacLean@faa.gov]
Sent: Monday, May 05, 2014 10:40 AM
To: Adams, Jim@Energy
Subject: RE: Ivanpah Info

Hi Jim,

That's a bit difficult to answer.

The area of influence (as in a radius of the site) at those altitudes would need to be reviewed for any assessment of the number of aircraft.
But, it is in the vicinity of a major overflight route to points northeast through east, in addition to Las Vegas Arrivals/Departures.

It is a significant number.

RX

Rex MacLean
Air Traffic Control Specialist
Western Service Center
Operations Support Group, AJV-W22
1601 Lind Avenue SW
Renton, WA 98057-3356

Office: (425) 203-4564
email: Rex.MacLean@faa.gov

Please contact the Northwest Mountain Regional Operations Center at (425) 227-2000 to be connected to the Tactical Operations Team 24-7 contact.

From: "Adams, Jim@Energy" <Jim.Adams@energy.ca.gov>
AJV-W22, Airspace & Procedures South Team
To: Rex MacLean/AWP/FAA@FAA,
Date: 05/05/2014 08:45 AM
Subject: RE: Ivanpah Info

Rex,

You can see the tracking data tops out at 20,000 feet MSL. Any idea how many aircraft fly higher than that (i.e. 30,000-36,000) on a daily basis?

Jim

From: Rex.MacLean@faa.gov [mailto:Rex.MacLean@faa.gov]
Sent: Wednesday, April 30, 2014 10:08 AM
To: JoIda.Reed@faa.gov
Cc: Valerie.S.Watson@faa.gov; Adams, Jim@Energy; Alex.CTR.Rushton@faa.gov
Subject: Ivanpah Info

Jolda,

The attached email concerning the Ivanpah Concentrated Solar Power Plant may be of interest during the ACF activity concerning Solar Power Plants.

Additionally, the attached Las Vegas Approach Letter To Airmen (LTA) was published on April 22.

RX

Rex MacLean
Air Traffic Control Specialist
Western Service Center
Operations Support Group, AJV-W22
1601 Lind Avenue SW
Renton, WA 98057-3356

Office: (425) 203-4564
email: Rex.MacLean@faa.gov

Please contact the Northwest Mountain Regional Operations Center at (425) 227-2000 to be connected to the Tactical Operations Team 24-7 contact.

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

Las Vegas TRACON
699 Wright Brothers Lane
Las Vegas, NV 89119

Issued: 04/22/2014 2206 (UTC)
Las Vegas TRACON

Effective: 05/05/2014 1200 (UTC)
Letter to Airmen: LTA-L30-3

Subject: Solar PowerPlant Glare

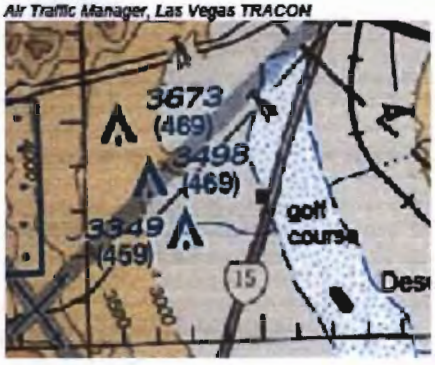
Cancellation: 05/04/2015 1200 (UTC)

Recently the Ivanpah Solar Electric Generating System at Ivanpah Dry Lake, CA (LAS189036-LAS193034) has commenced generating electricity. This plant covers approximately 3,500 acres west of Interstate Highway 15 near the California-Nevada State Line with roughly 175,000 mirrors surrounding each of three collection towers. These towers employ a new technology that has not been utilized at this level before.

Beginning in August 2013, as the facility neared completion, Las Vegas Terminal Radar Approach Control (TRACON) and Los Angeles Air Route Traffic Control Center (ARTCC) began receiving numerous pilot reports of glare associated with the power plant. Since December 2013, when the facility began production, more reports have surfaced.

To appropriately document these conditions, Pilots and other air crew members are urged to utilize NASA's Aviation Safety Reporting System (ASRS) and provide an Electronic Report Submission (ERS) via the web at http://asrs.arc.nasa.gov/report/electronic.html

John Howard
Air Traffic Manager, Las Vegas TRACON



April 29, 2014

Joseph Douglas, Compliance Project Manager
California Energy Commission
Siting, Transportation and Environmental Protection Division
1516 9th Street
Sacramento, CA 95814

RE: Response to ACN: 1156120

Dear Mr. Douglas:

The Ivanpah Solar Electric Generation System (ISFGS) is providing this letter to the California Energy Commission (CEC) in compliance with Condition of Certification (CoC) TRANS-3 and Section 6.5 of the Heliostat Positioning Plan (HPP). The HPP requires that ISFGS address complaints as soon as practicable and report the results. This letter is in response to the email sent to Mr. Doug Davis on April 16, 2014 from Joe Douglas of the CEC. A pilot report was attached to this email (RE: ACN: 1156120).

In accordance with the HPP, Dr. Clifford Ho of Sandia National Laboratories visited the site on April 24th and 25th to obtain measurements. Dr. Ho is currently in the process of evaluating the results of his observations and measurements. Following the analysis of the data collected, a full report will be provided. The CEC and relevant agencies identified in Section 6.5 of the Heliostat Positioning Plan will receive a copy of the report once it is complete. ISEGS will also facilitate meetings with Dr. Ho to review the results of his work.

ISEGS appreciates the continuing cooperation of the Commission staff. Please feel free to contact me directly should you have any questions.

Sincerely,

Shankara Babu PhD, CHMM, CEM
ESH Manger

Ivanpah Solar Thermal
1D0302 Yates Well Road
Nipton, CA 92364
Office: (702)815-2012

CC: Michael W. Ahrens, BLM Field Manager

Adams, Jim@Energy

From: Daniel.Rollins@faa.gov
Sent: Tuesday, June 10, 2014 8:35 AM
To: Adams, Jim@Energy; Johanna.Forkner@faa.gov
Cc: Flores, David@Energy; Koch, Andrea@Energy
Subject: RE: Request for Ivanpah report
Attachments: Ivanpah.pptx

Jim,

Attached is the Ivanpah analysis. It follows the same format as the Palen analysis, with the same information slides. I added comments to each slide to explain some of our aviation terms, as well as the aircraft type and airport ID information.

In this study there were military flights above 50,000' MSL. For security reasons, these flights were removed from the images. However, they are included in the flight count on slide six.

If you have any questions, please let me know.

Dan Rollins
Air Traffic Control Specialist
FAA Western Service Center
Operations Support Group (AJV-W2)
Tactical Operations Team
Analysis Lead
Renton WA 98057

Western Service Center ACT2 Administrator
and Contingency Plan Focal
ACT2 Web Site

425-203-4516 Office
425-306-2479 Blackberry
425-203-4580 FAX

From: Adams, Jim@Energy [mailto:Jim.Adams@energy.ca.gov]
Sent: Monday, June 09, 2014 9:50 AM
To: Forkner, Johanna (FAA)
Cc: Rollins, Daniel (FAA); Flores, David@Energy; Koch, Andrea@Energy
Subject: Request for Ivanpah report

Johanna,

My colleagues and I were very impressed with the Palen Aeronautical Study Dan generated. It will be useful in educating Energy Commissioners, their advisers and staff, parties to the proceeding, intervenors and members of the public. We would like to have a similar report for Ivanpah Solar Electric Generating System (ISEGS). Clark County (Nevada) Department of Aviation gave us some data but it was not as detailed as the Palen Study. Aeronautical information for ISEGS during the month of May 2014 would be directly comparable to the Palen data. We appreciate the FAA's involvement in providing information important to our investigation of solar power tower projects generating significant glare.

Thank you,

ATTACHMENT 9

Jim

Ivanpah Solar Project

Aeronautical Study

Federal Aviation Administration

Presented to: California Energy Commission

By: Western Service Center Operations Support Group

Date: June 2014

Ivanpah Aeronautical Study

- **California Energy Commission requested aeronautical information in the area of the Ivanpah Solar Project**

- **Requested flight information within a 15nm radius of the project location, at all altitudes**

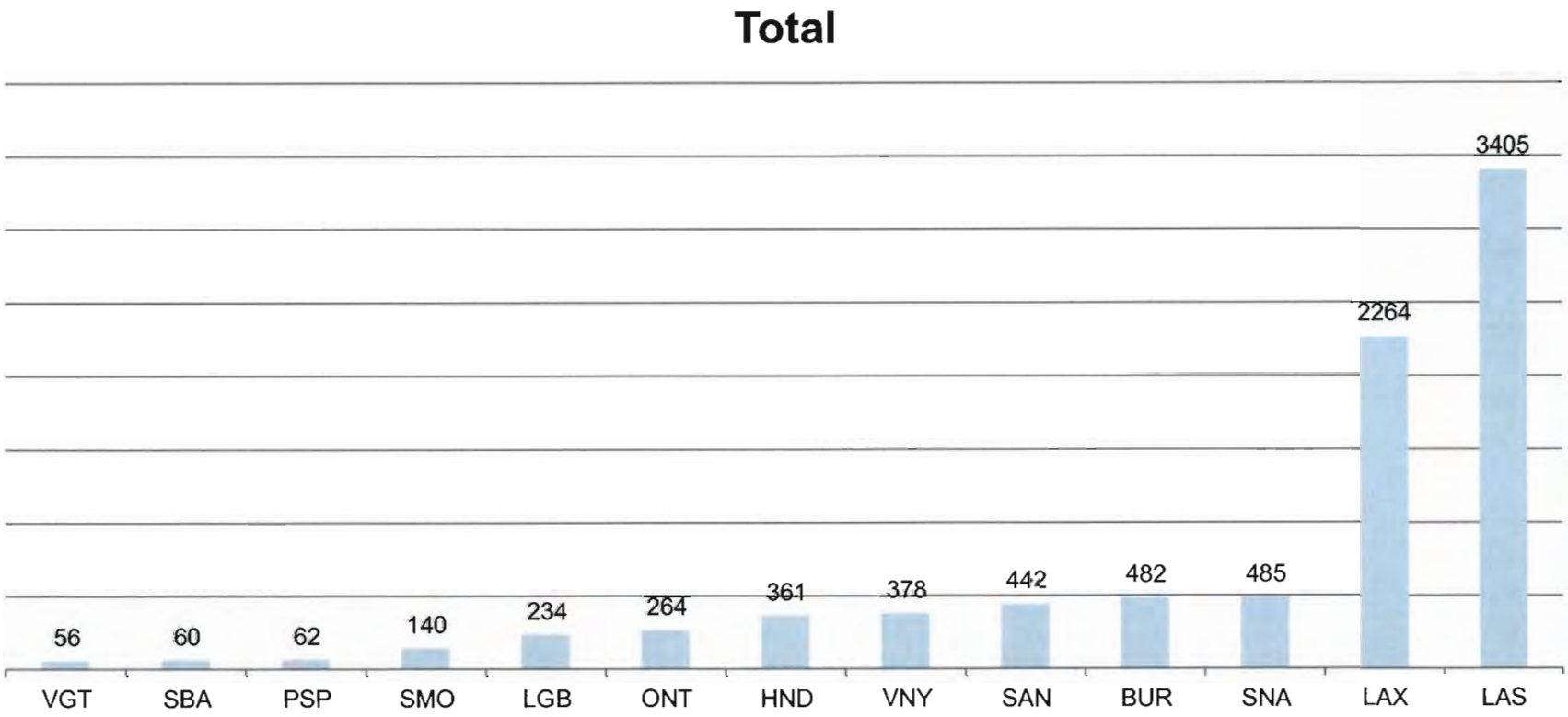
Analysis Parameters

- Using the Performance Data Analysis and Reporting System (PDARS)
- Traffic data from the Los Angeles Air Route Traffic Control Center (ZLA ARTCC)
- May 2014 (complete month)
- Examined center-point 35°33'23.87"N, 115°28'13"W

Analysis Limitations

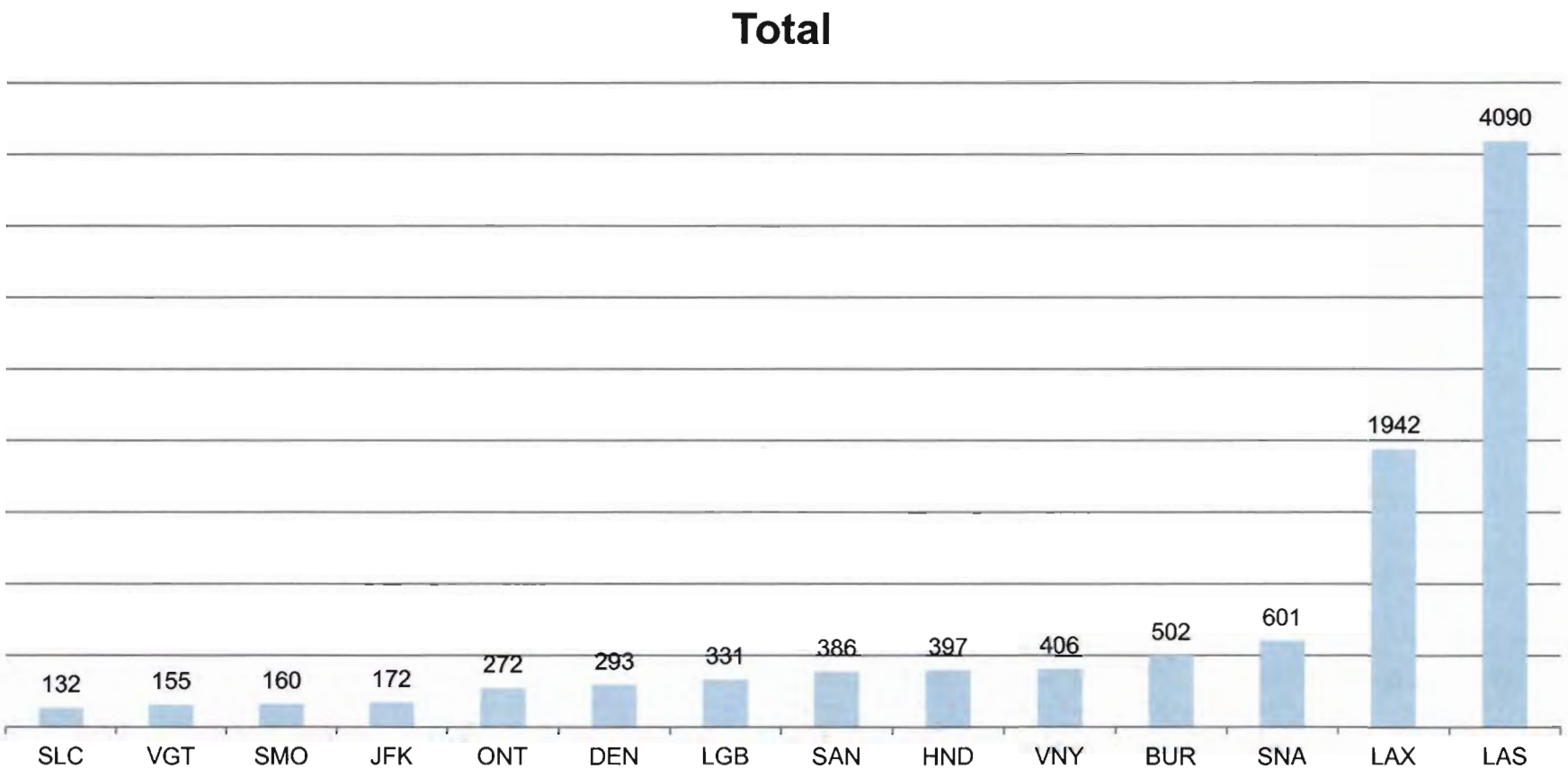
- **No Visual Flight Rules (VFR) flights shown**
  - This is a data limitation, and are not available
- **Radar limitations in the area may result in some low altitude flights being missed**
  - This should be a very limited amount
- **Occasionally flights tracks split, causing multiple counts for one flight. Therefore total track count may not equal total flight count**
- **45 flights through the region did not contain flight information, such as type, arrival or departure airport. These were general aviation, military or unidentified targets being tracked by Air Traffic Control for various reasons**

List of Departure Airports



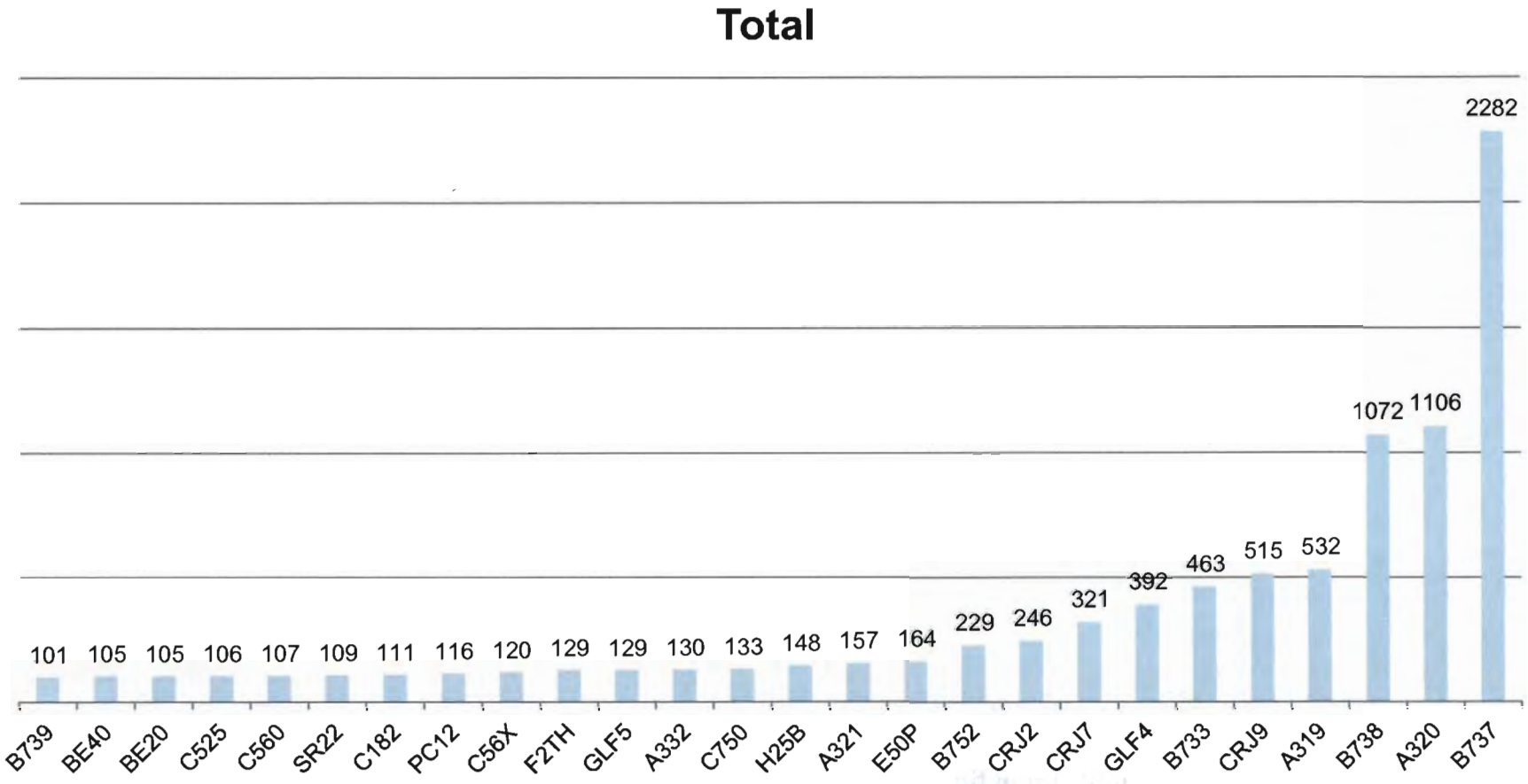
Airports with 50 or more departures through the examined area

List of Arrival Airports



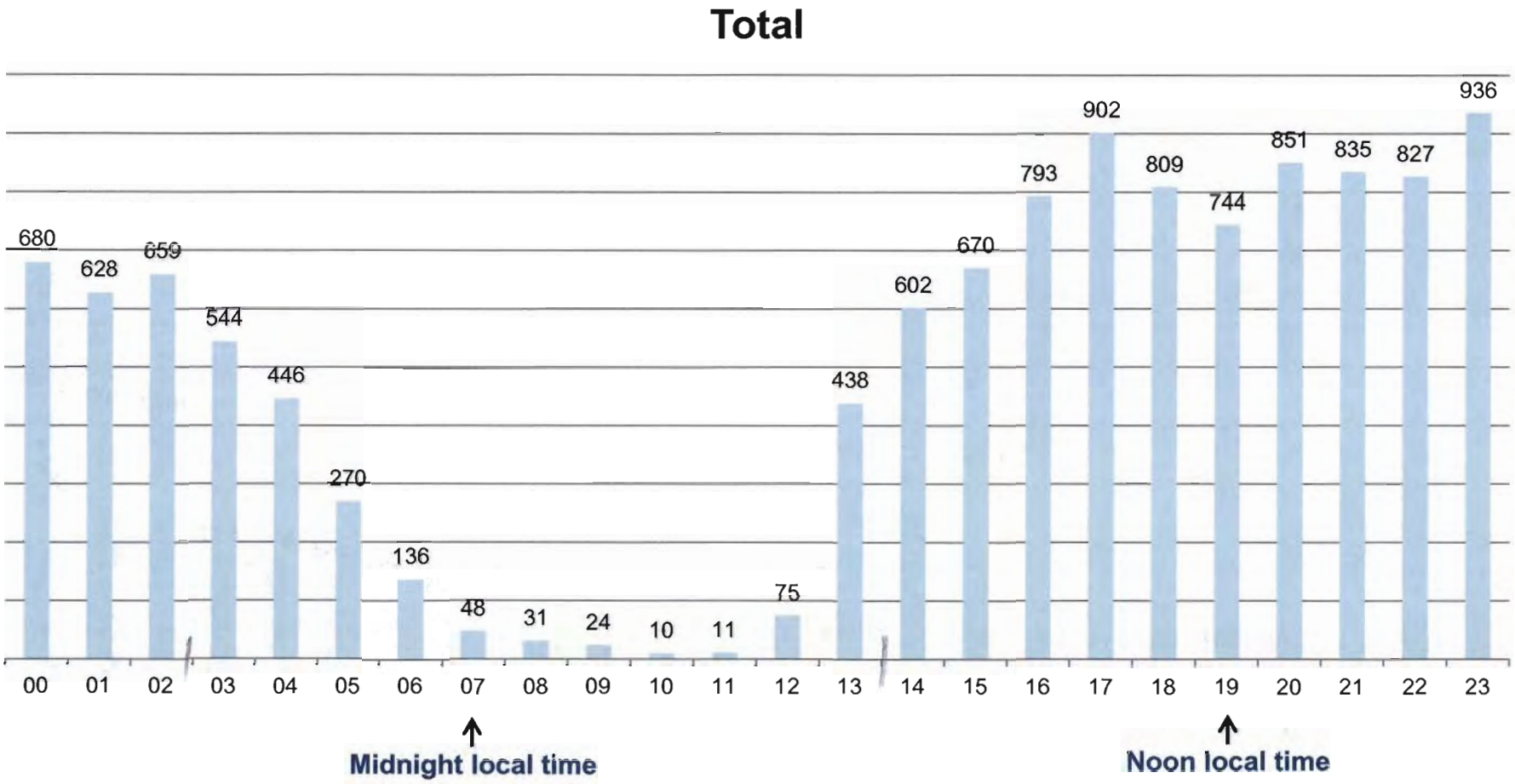
Airports with 100 or more arrivals through the examined area

Aircraft Types

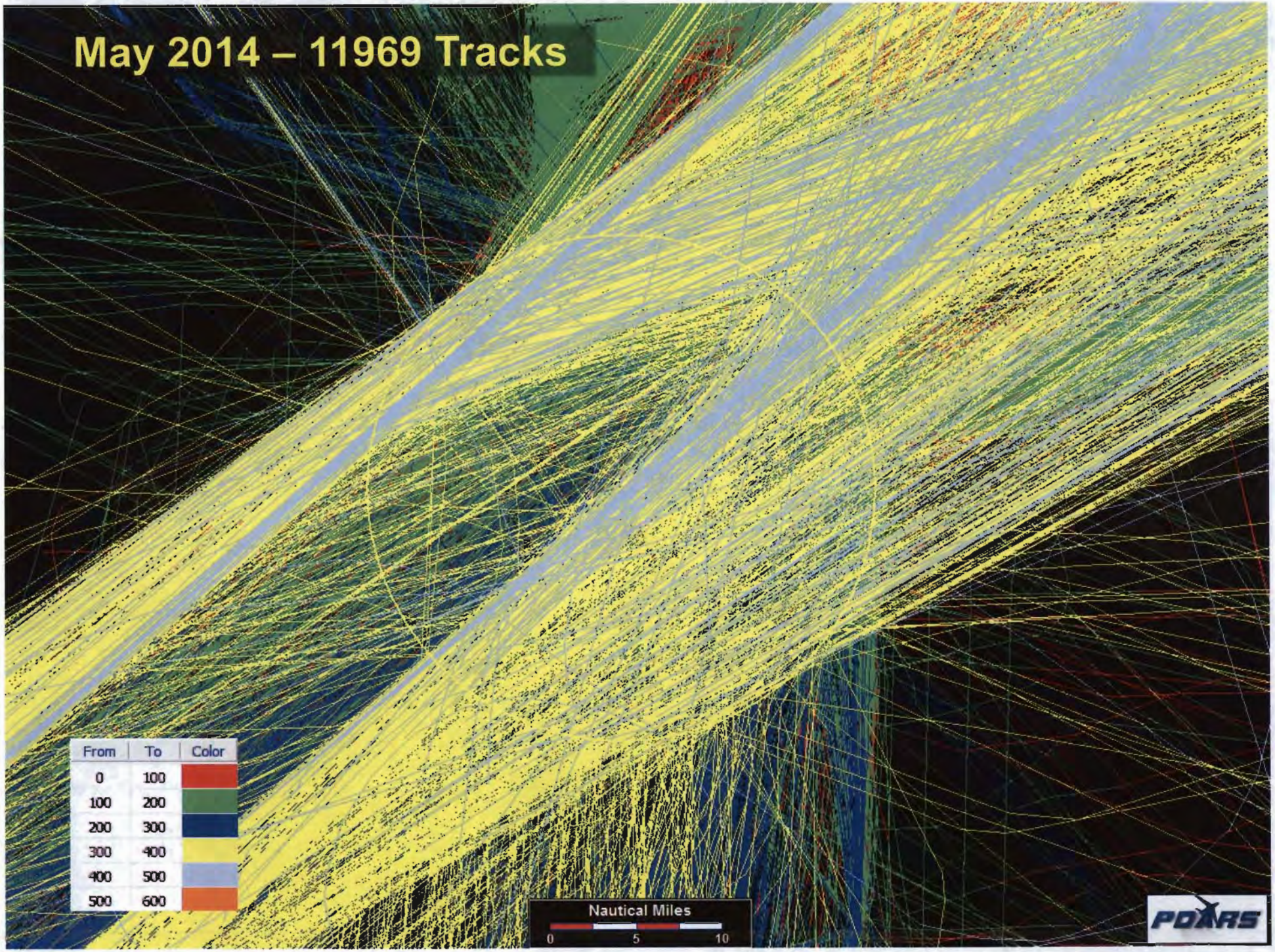


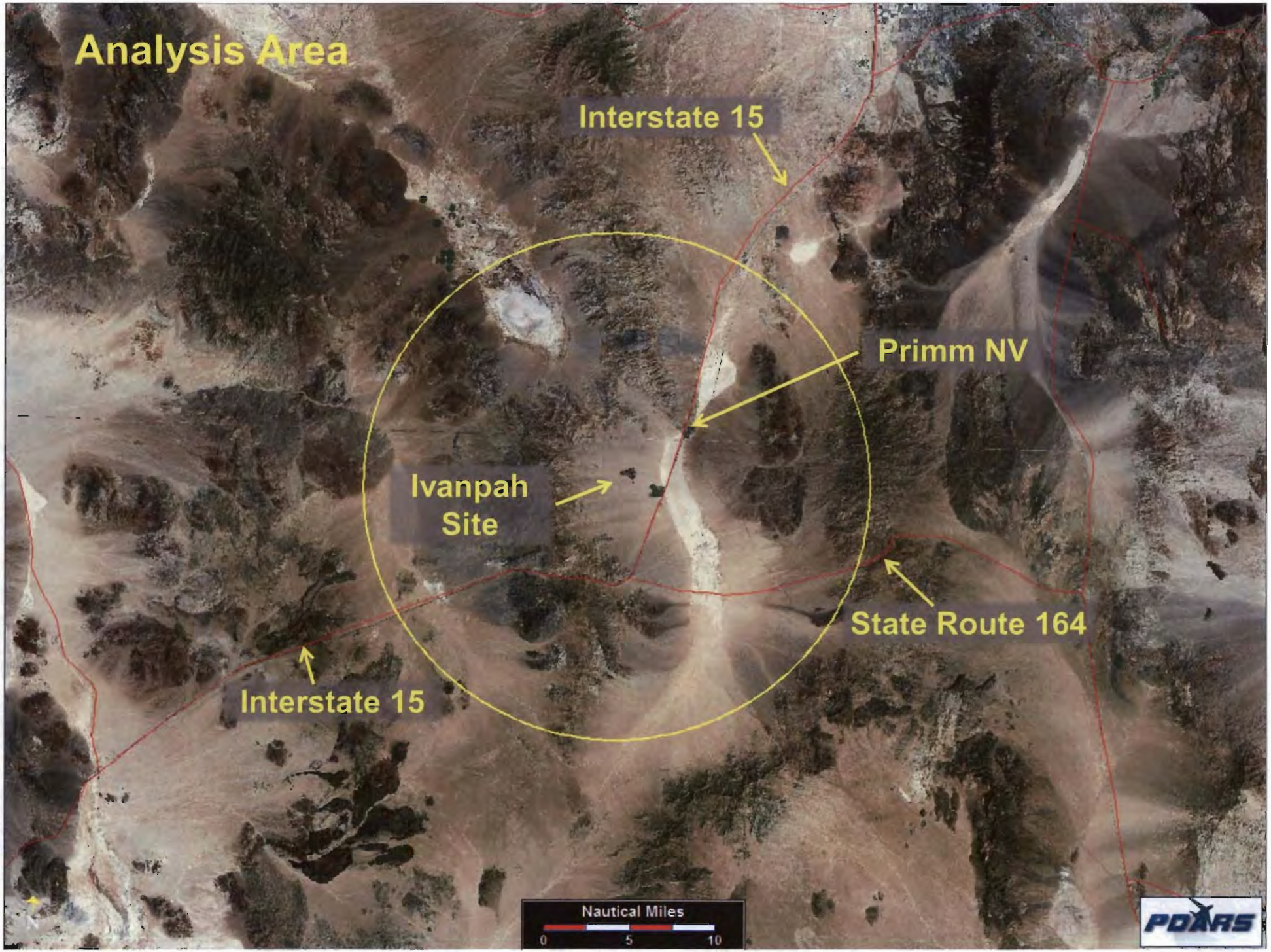
Aircraft with 100 or more types through the examined area

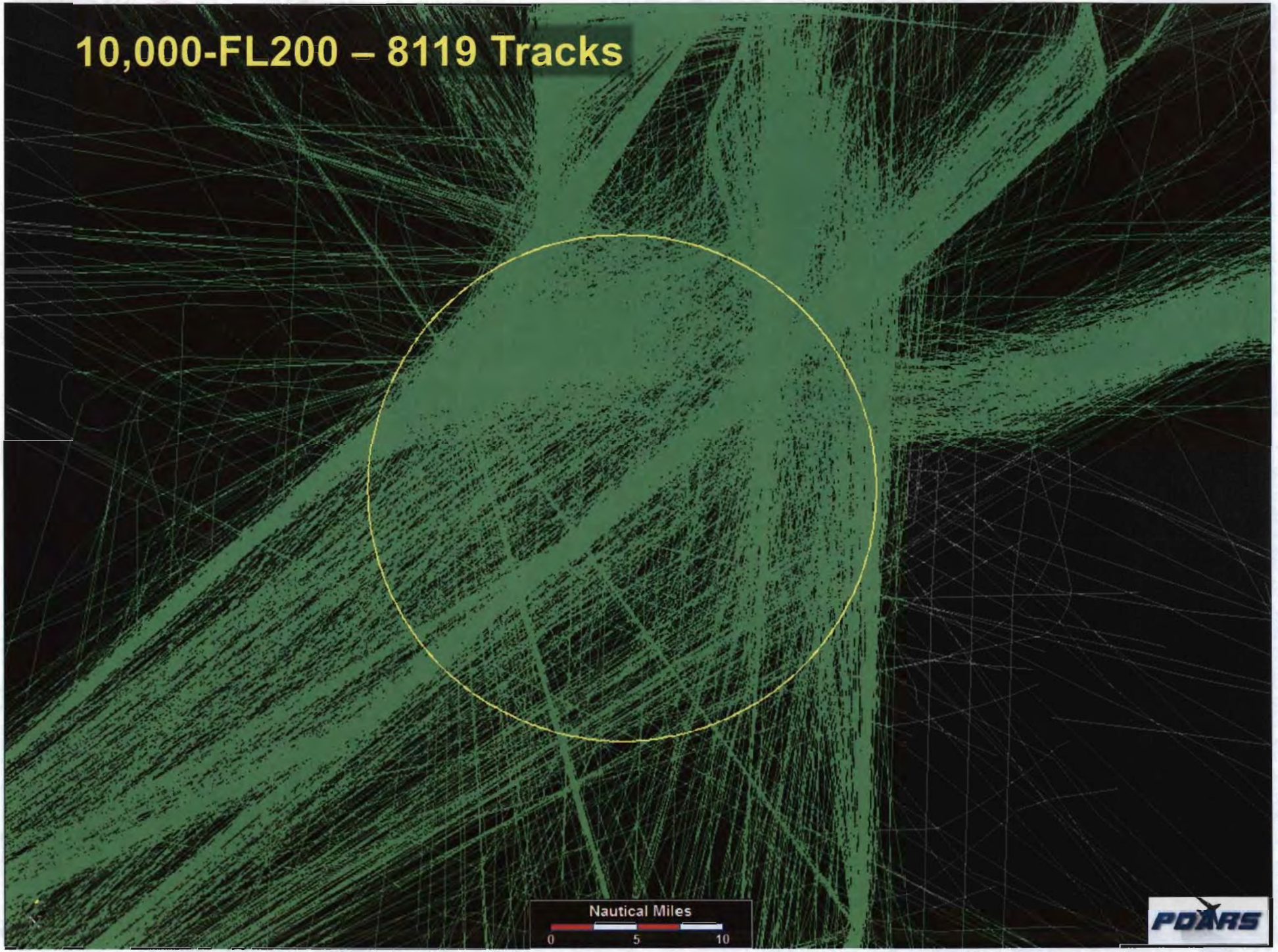
Time of Day



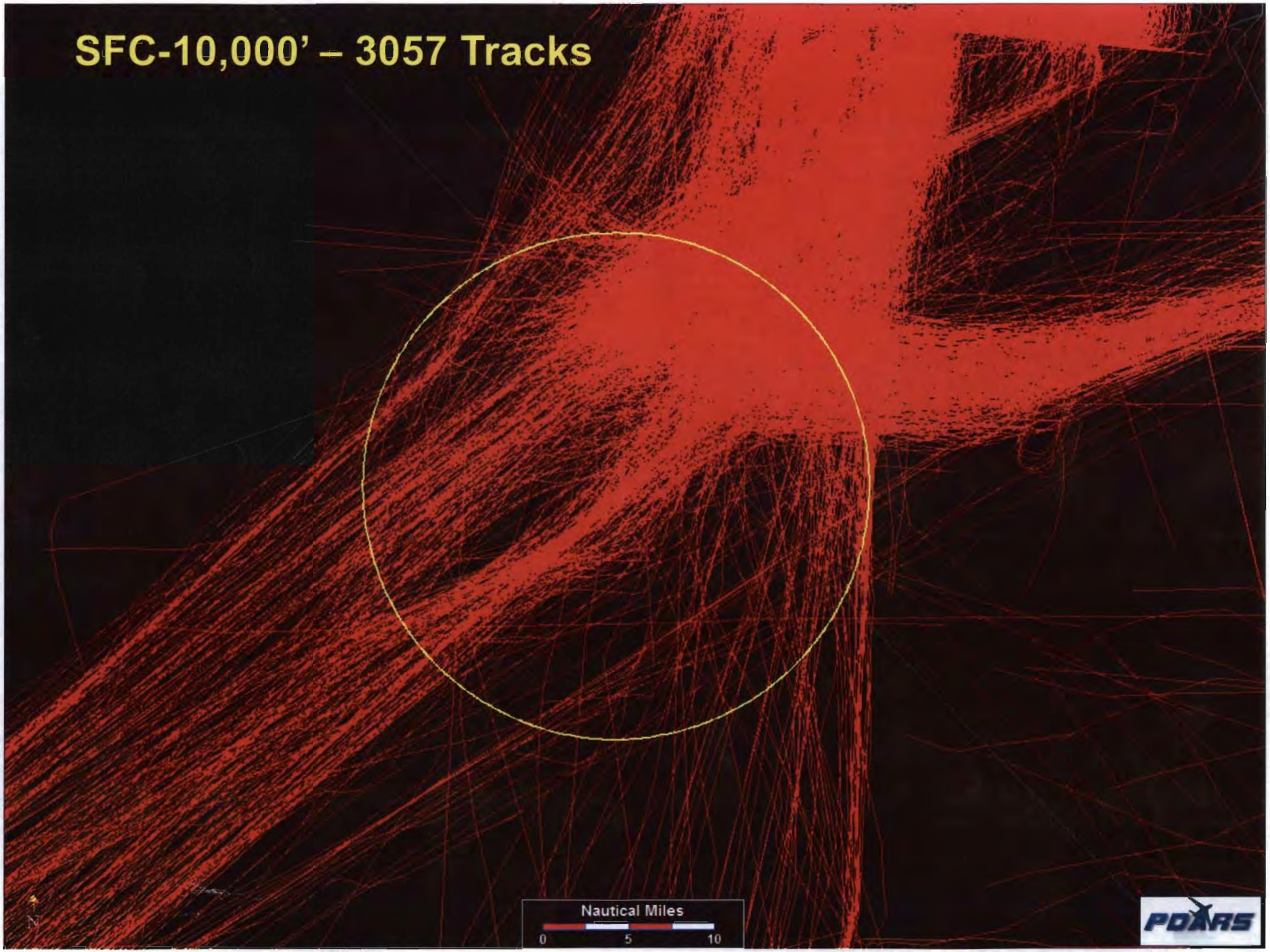
Times are in UTC: 0000 UTC = 1700 Pacific Daylight Time

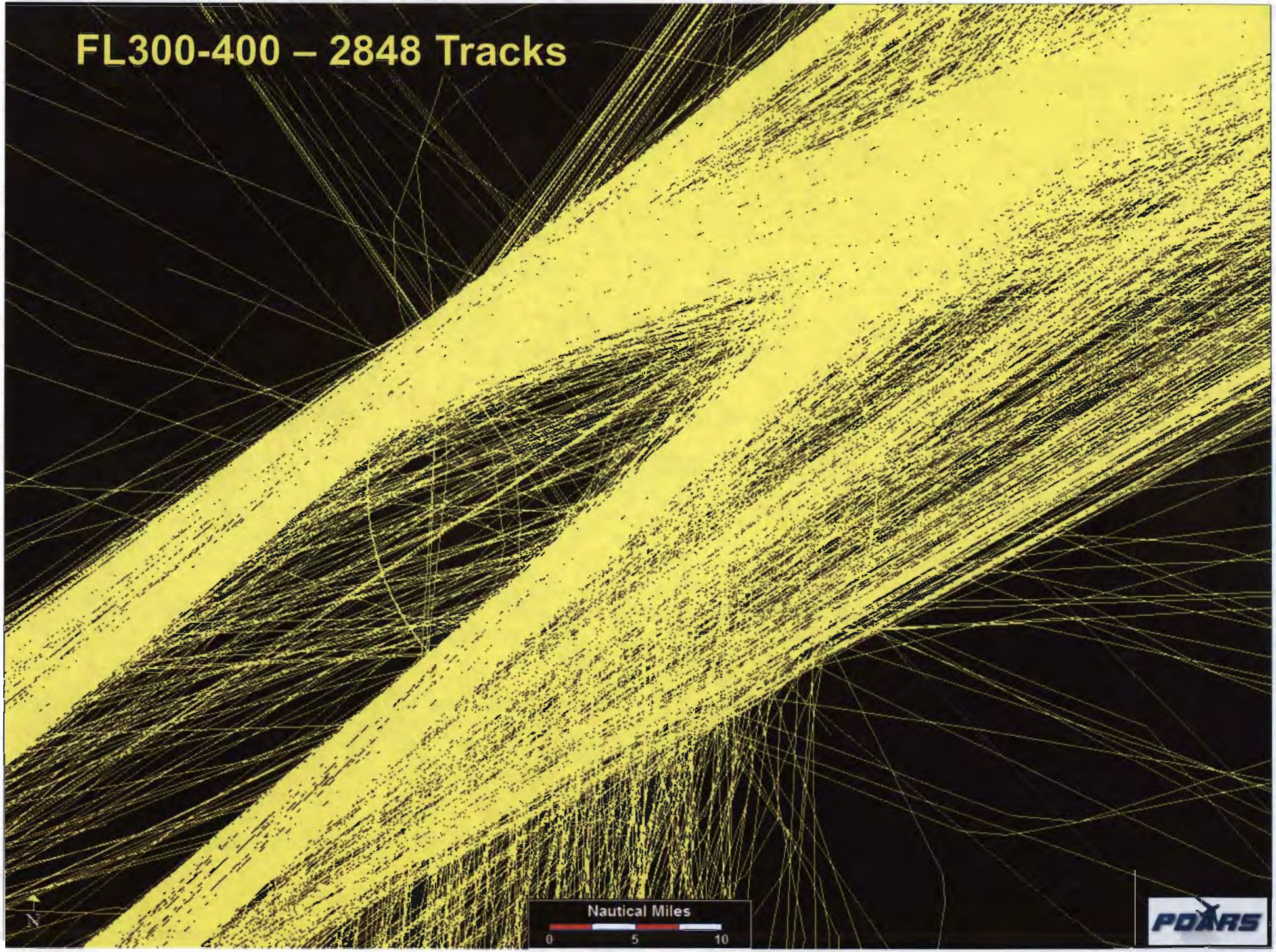

May 2014 – 11969 Tracks
From
To
Color
0
100
100
200
200
300
300
400
400
500
500
600
Nautical Miles
0
5
10
POLARIS


Analysis Area
Interstate 15
Primm NV
Ivanpah Site
State Route 164
Interstate 15
Nautical Miles
0
5
10
PDARS

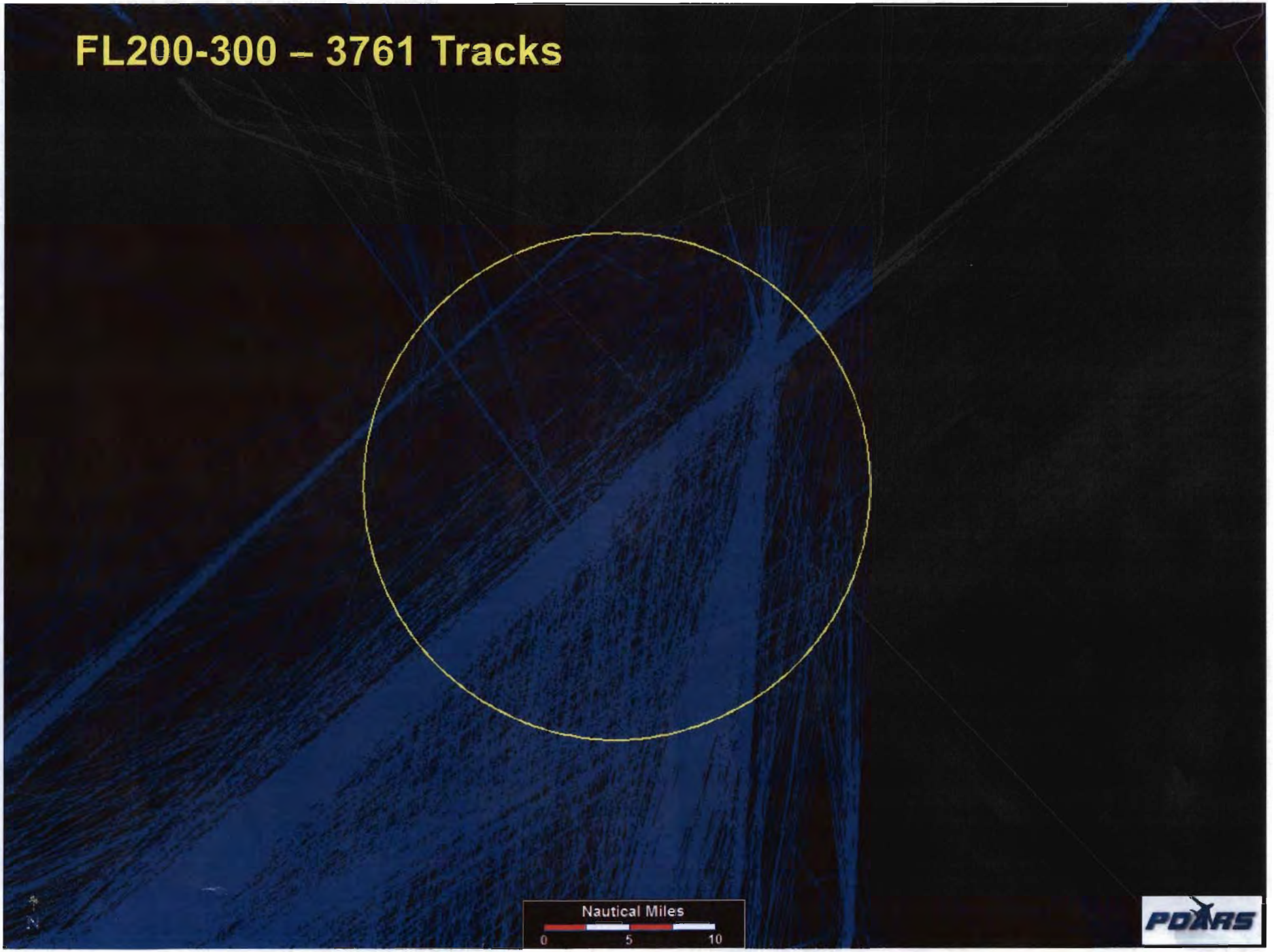

10,000-FL200 – 8119 Tracks
Nautical Miles
0
5
10
PDARS

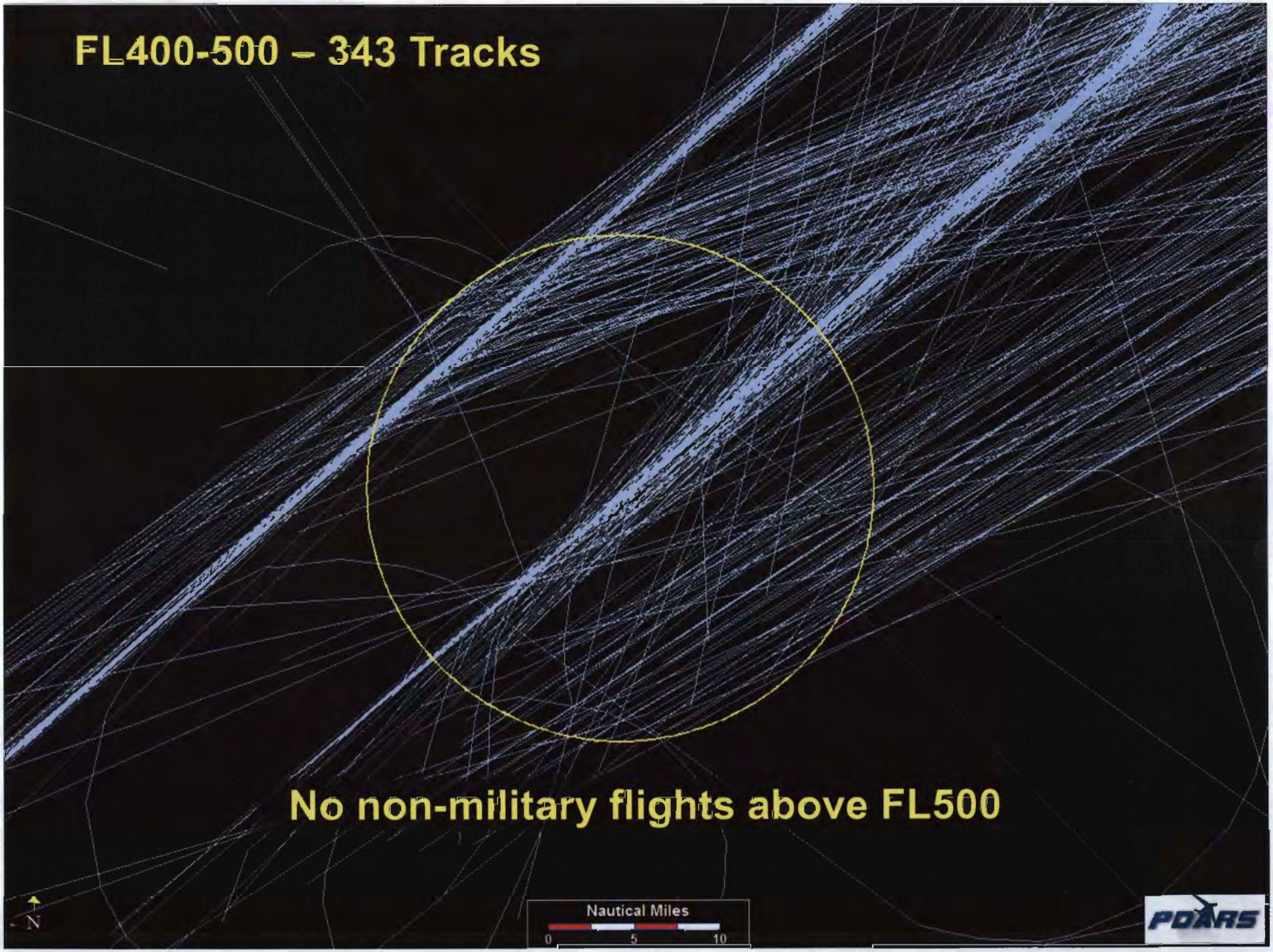
SFC-10,000' – 3057 Tracks




FL300-400 – 2848 Tracks
Nautical Miles
0
5
10
N
POLARS

FL200-300 – 3761 Tracks




FL400-500 – 343 Tracks
No non-military flights above FL500
N
Nautical Miles
0
5
10
POARS

Observations

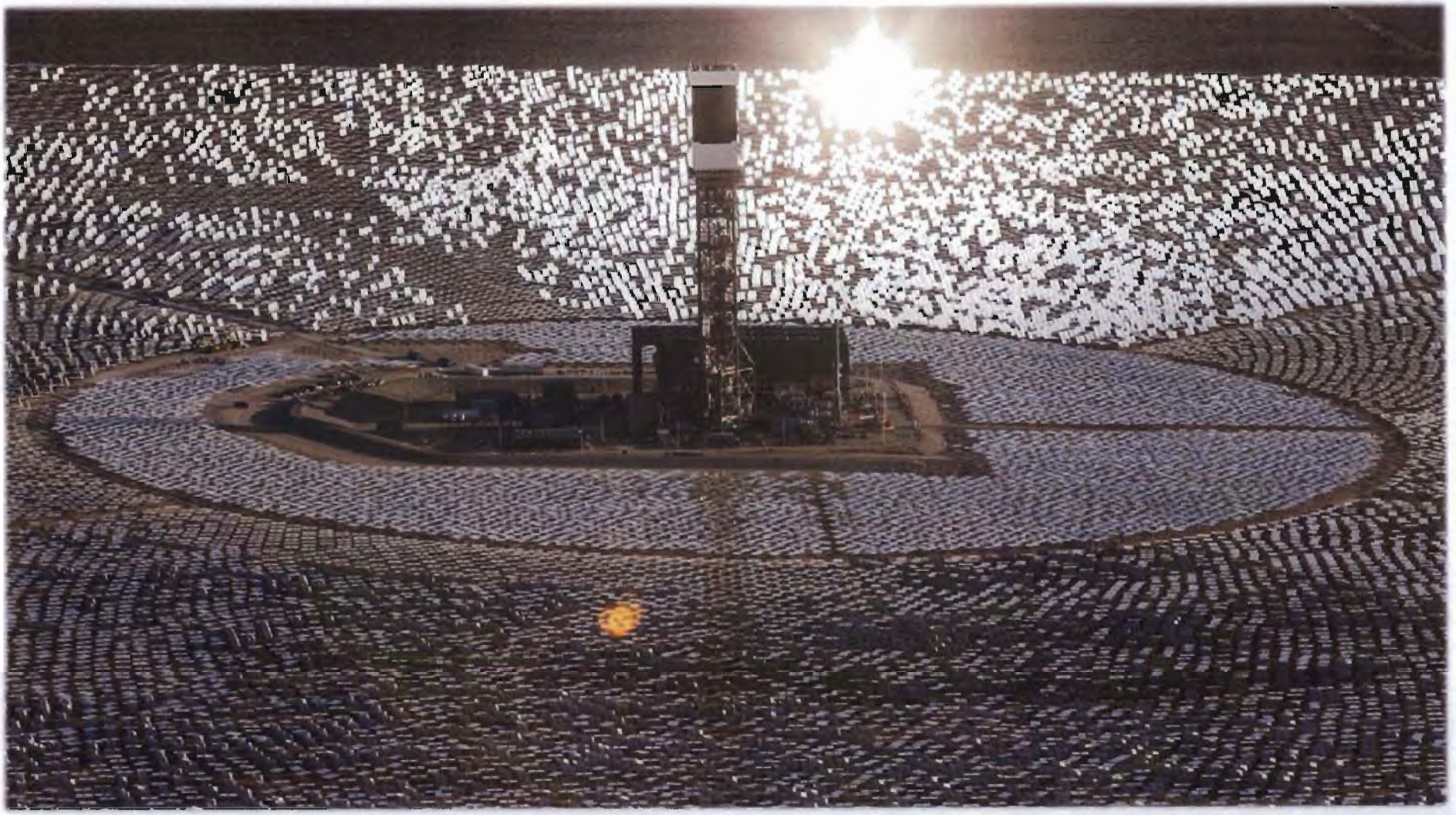
- Below FL300 the majority of flights are to/from the Las Vegas area airports (LAS, VGT & HND)

- Heaviest departure and arrival airport demand is LAX and the Las Vegas area airports

- Above FL300 practically all flights are to/from southern California airports

- Majority of flights are commercial jets with 70 passenger seats or more

Questions?



Adams, Jim@Energy

From: Rex.MacLean@faa.gov
Sent: Friday, November 07, 2014 3:45 PM
To: Adams, Jim@Energy
Subject: Aeronautical Charting Forum (ACF) Follow-up
Attachments: Ivanpah CSP Los Angeles Sectional.jpg; Tonopah CSP Las Vegas Sectional.jpg

Hello Jim,

The ACF has concurred with the recommendation to chart Solar Plants on Section Aeronautical Charts as visual landmarks. Both, the Ivanpah and Tonopah Concentrated Solar Plants (CSP) have been charted. We're looking at other type plants to identify charting needs. Please see the attached copies of the two charts.

At the last ACF in late October, the recommendation to chart CSPs with a ocular hazard symbol, in summation, was tabled awaiting more information. I'm still waiting for the official minutes, but there are suggestions that symbology may change. If it does, I suspect we would limit charted depictions to CSPs only.

Should you have any questions regarding this matter, please contact me.

RX

Rex MacLean
Air Traffic Control Specialist
Western Service Center
Operations Support Group, AJV-W22
1601 Lind Avenue SW
Renton, WA 98057-3356

Office: (425) 203-4564
email: Rex.MacLean@faa.gov

Please contact the Northwest Mountain Regional Operations Center at (425) 227-2000 to be connected to the Tactical Operations Team 24-7 contact.

ATTACHMENT 10

Marxen, Chris@Energy

From: Adams, Jim@Energy
Sent: Thursday, April 10, 2014 8:53 AM
To: Marxen, Chris@Energy
Cc: Flores, David@Energy; Douglas, Joseph@Energy
Subject: FW: Recent ASRS report

Box 1f.

From: Adams, Jim@Energy
Sent: Thursday, April 10, 2014 8:52 AM
To: 'CONNELL, LINDA (ARC-TH)'
Subject: RE: Recent ASRS report

Thanks Linda...I sent this to my contacts at FAA and Caltrans Aeronautics. We would like to meet with FAA staff at Palmdale and talk about developing a better process for getting relevant information about glare incidents in a more timely manner.
Jim

From: CONNELL, LINDA (ARC-TH) [mailto:linda.j.connell@nasa.gov]
Sent: Wednesday, April 09, 2014 5:54 PM
To: Adams, Jim@Energy
Subject: Recent ASRS report

Jim
Attached is the most recent report we have received here at ASRS. This report was received in March from a Captain of a corporate aircraft. This pilot reports being on the KPEC3 arrival to Las Vegas when encountering "mirror reflections". The pilot reports this was at 13,000 ft (Mean Sea Level).
Regards,
Linda

Linda Connell, NASA ASRS Director
NASA Ames Research Center
Moffett Field, CA 94035-0001
NASA Ames Office (650) 604-0795
ASRS Director Office (408) 541-2827
ASRS Main Office (408) 541-2802

ATTACHMENT 11

ACN: 1156120

Time
Date: 201403
Local Time Of Day: 0601-1200

Place
Locale Reference.ATC Facility: ZLA.ARTCC
State Reference. : CA
Altitude.MSL.Single Value.MSL: 13000

Environment
Flight Conditions: VMC
Light: Daylight

Aircraft: 1
Reference.X: X
ATC / Advisory.Center. : ZLA
Aircraft Operator: Corporate
Make Model Name: Light Transport, Low Wing, 2 Turbojet Eng
Crew Size.Number Of Crew.Flight Crew Size: 2
Operating Under FAR Part: Part 91
Flight Plan: IFR
Mission: Passenger
Nav In Use: FMS Or FMC
Flight Phase: Descent
Route In Use.STAR. : KEPEC3
Airspace.Class E. : ZLA

Person: 1
Reference. : 1
Location Of Person.Aircraft. : X
Location In Aircraft: Flight Deck
Reporter Organization: Corporate
Function.Flight Crew: Captain
Function.Flight Crew: Pilot Flying
Qualification.Flight Crew: Air Transport Pilot (ATP)
Qualification.Flight Crew: Multiengine
Experience.Flight Crew.Total. : 5000
Experience.Flight Crew.Last 90 Days. : 45
Experience.Flight Crew.Type. : 2400
ASRS Report Number.Accession Number.ACN: 1156120
Analyst Callback: Completed

Events

Anomaly.ATC Issue: All Types
Anomaly.Flight Deck / Cabin / Aircraft Event: Illness
Anomaly.Deviation - Procedural: Published Material / Policy
Detector.Person.Flight Crew: Flight Crew
When Detected: In-flight
Result.General: Physical Injury / Incapacitation
Result.Flight Crew: Requested ATC Assistance / Clarification
Result.Flight Crew: Took Evasive Action

Assessments

Contributing Factors / Situations: Airspace Structure
Contributing Factors / Situations: Environment - Non Weather Related
Contributing Factors / Situations: Human Factors
Contributing Factors / Situations: Procedure
Primary Problem: Ambiguous

Narrative: 1

While on the KEPEC3 arrival into LAS we were temporary blinded by bright lights (reflections) from the ground. These reflections, coming from the new solar power station were so bright that any attempt to look outside the plane was met with pain and temporary blindness even when looking back inside. Any attempt to see and avoid was useless and trying to find the airport during this time was painful as well. Exposure lasted about 5 minutes. We notified ATC and were told that they get a lot of complaints about these reflections.

Callback: 1

The reporter stated that he was in the left seat and viewed the mirror reflections for only seconds then was able to get his head sheltered below the glareshield and away from the light. However even after the brief exposure, he had blue dots in his vision for about 5 minutes. The First Officer had no way to avoid the light even while not looking directly at it. The First Officer was literally blind for a greater than five minutes and neither pilot's vision was capable of detecting objects outside of the cockpit for a period of time. When the crew reported the event to ATC, the response was "Yes, we get lots of complaints."

Synopsis

A Captain flying the LAS KEPEC3 arrival near the CLARR waypoint reported his vision distortion and First Officer's temporary blindness after encountering the intense sunlight reflection at 13,000 FT.

Adams, Jim@Energy

From: CONNELL, LINDA (ARC-TH) [linda.j.connell@nasa.gov]
Sent: Tuesday, September 02, 2014 2:20 PM
To: Rex.MacLean@faa.gov
Cc: Adams, Jim@Energy; Brian.J.Johnson@faa.gov; Ian.Gregor@faa.gov
Subject: Re: NASA ASRS Reports on Solar Glare
Attachments: Solar Plant Glare Incidents_08292014.pdf

Now with the attachment.

From: <CONNELL>, Linda Connell <linda.j.connell@nasa.gov>
Date: Tuesday, September 2, 2014 2:15 PM
To: "Rex.MacLean@faa.gov" <Rex.MacLean@faa.gov>
Cc: "Adams, Jim@Energy" <Jim.Adams@energy.ca.gov>, "Brian.J.Johnson@faa.gov" <Brian.J.Johnson@faa.gov>, "Ian.Gregor@faa.gov" <Ian.Gregor@faa.gov>
Subject: NASA ASRS Reports on Solar Glare

Rex,
Attached are 5 additional reports we have received. I have included them as an ASRS Recurring Search Request. We will not prepare an Alert at this time since we have contact with you and others.

This should add to the 3 others we have sent (2 with our original ASRS Alert Bulletin and 1 in April). We have a total of 8 reports in our collection. All are describing Ivanpah.

Thanks
Linda

Linda Connell, NASA ASRS Director
NASA Ames Research Center
Moffett Field, CA 94035-0001
NASA Ames Office (650) 604-0795
ASRS Director Office (408) 541-2827
ASRS Main Office (408) 541-2802

ATTACHMENT 12

ACN: 1184374

Time
Date: 201406
Local Time Of Day: 1201-1800

Place
Locale Reference.Airport: LAS.Airport
State Reference: NV
Altitude.MSL.Single Value: 18000

Environment
Flight Conditions: VMC
Light: Daylight

Aircraft 1
ATC / Advisory.Center: ZLA
Aircraft Operator: Air Carrier
Make Model Name: B737 Next Generation Undifferentiated
Operating Under FAR Part: Part 121
Nav In Use: FMS Or FMC
Flight Phase: Climb

Person 1
Reporter Organization: Air Carrier
Function.Flight Crew: First Officer
Function.Flight Crew: Pilot Not Flying
Qualification.Flight Crew: Air Transport Pilot (ATP)
ASRS Report Number: 1184374

Events
Anomaly.Inflight Event / Encounter: Other / Unknown
Detector.Person: Flight Crew
Result.General: None Reported / Taken

Assessments
Contributing Factors / Situations: Environment - Non Weather Related
Primary Problem: Environment - Non Weather Related

Narrative 1
[We] noticed a great deal of glare from the western most solar generator at the Ivanpah Solar Farm. We were flying the SHEAD 8 departure from Runway 7L and experienced significant glare from approximately MINEY until approximately 20 miles east of SHEAD. The glare was significantly stronger than from the other two stations and appeared to be due to poor aiming of the mirrors. In addition to overall glare, there were spots of glare separate from the rest of the mirror farm. While we were westbound, and the glare was more of a distraction, it would have been very difficult for us to fly southbound and pick out traffic from below and/or have to stare into that light. We mentioned the glare to LAX Center. The flight continued normally after SHEAD.

Synopsis
An air carrier pilot climbing through approximately FL180 on the LAS SHEAD 8 RNAV SID commented on the Solar Farm glare while flying northwest between HITME and SHEAD intersections around early afternoon.

ACN: 1182901

Time
Date: 201406
Local Time Of Day: 1201-1800

Place
Locale Reference.Navaid: LAS.VORTAC
State Reference: NV
Altitude.MSL.Single Value: 10000

Environment
Flight Conditions: VMC
Light: Daylight

Visual meteorologic condition

Aircraft 1
ATC / Advisory.TRACON: LAS
Make Model Name: Beech 1900
Operating Under FAR Part: Part 91
Flight Phase: Descent

Person 1
Function.Flight Crew: Captain
Function.Flight Crew: Pilot Flying
Qualification.Flight Crew: Air Transport Pilot (ATP)
Qualification.Flight Crew: Flight Instructor
Qualification.Flight Crew: Instrument
Qualification.Flight Crew: Multiengine
Experience.Flight Crew.Total: 9600
Experience.Flight Crew.Last 90 Days: 90
Experience.Flight Crew.Type: 2000
ASRS Report Number: 1182901

Events
Anomaly.Inflight Event / Encounter: Other / Unknown
Detector.Person: Flight Crew
Result.General: None Reported / Taken

Assessments
Contributing Factors / Situations: Environment - Non Weather Related
Contributing Factors / Situations: Human Factors
Primary Problem: Human Factors

Narrative 1
Extreme solar glare from a solar power plant creates a hazard for pilots flying the CRESO3 arrival into Las Vegas. Route segments from DANBY - SARAS - WHIGG - CRESO cause aircraft to fly directly toward/overfly the new solar power plant. Light reflected from the mirrors and the central towers is blinding, making it difficult to visually clear the airspace. Additionally, the bright light creates "sun spots" in the pilot's vision. I fly this route several times a week and have experienced these hazards every time the sun is visible.

Synopsis

Beech 1900 Captain reports the new solar power plant southwest of Las Vegas is a visual hazard

while flying the CRESO3 arrival to LAS.

ACN: 1184458

Time
Date: 201406
Local Time Of Day: 1201-1800

Place
Locale Reference.Airport: 0L7.Airport
State Reference: NV
Altitude.MSL.Single Value: 12000

Environment
Flight Conditions: VMC
Light: Daylight

Aircraft 1
Aircraft Operator: Personal
Make Model Name: Sail Plane
Operating Under FAR Part: Part 91
Flight Phase: Climb
Flight Phase: Cruise
Flight Phase: Descent

Person 1
Reporter Organization: Personal
Function.Flight Crew: Pilot Flying
Function.Flight Crew: Single Pilot
Qualification.Flight Crew: Air Transport Pilot (ATP)
Qualification.Flight Crew: Multiengine
Experience.Flight Crew.Total: 11645
Experience.Flight Crew.Last 90 Days: 25
Experience.Flight Crew.Type: 145
ASRS Report Number: 1184458

Events
Anomaly.Inflight Event / Encounter: Other / Unknown
Detector.Person: Flight Crew
Result.General: None Reported / Taken

Assessments
Contributing Factors / Situations: Environment - Non Weather Related
Primary Problem: Environment - Non Weather Related

Narrative 1

I have flown from the 0L7 [for several years]. 0L7 is located about 12 miles northeast of the Ivanpah Solar Power Plant. My flying is conducted between March and October of each year during VMC conditions. My flight experience covers the time period prior to, during the construction of, and subsequent to the operational start of the power plant. Since the start of the power plant, my flight paths have been directly and obliquely toward, directly over, and around the power plant location at altitudes varying from initial launch (2,882 FT MSL, 0 FT AGL at Jean) to about 12,000 FT MSL.

The glare from one of the power plant towers is visible from ground at the Jean airport. As the

aircraft's altitude is increased, the glare from the other two towers as well as the surrounding mirror fields becomes visible. The intensity of the glare from the towers appears to be fairly constant once line-of-sight is obtained whereas the glare from the mirror fields varies depending on altitude, the aircraft's direction relative to the power plant, and sun angle. At worst, the glare is annoying and a distraction. To date, I have not experienced anything remotely close to flash blindness or cockpit illumination.

Synopsis

A sail plane pilot flying regularly from 0L7 comments on the Solar Plant glare and notes the tower glare is fairly constant whereas the mirror array glare varies with altitude, flight direction and sun angle. He has experienced no adverse effects from the array light.

ACN: 1194004

Time
Date: 201408
Local Time Of Day: 0001-0600

Place
Locale Reference.ATC Facility: ZLA.ARTCC
State Reference: CA
Altitude.MSL.Single Value: 8600

Environment
Flight Conditions: VMC

Aircraft 1
ATC / Advisory.Center: ZLA
Aircraft Operator: Personal
Make Model Name: M-20 J (201) / Allegro
Operating Under FAR Part: Part 91
Flight Phase: Climb

Person 1
Reporter Organization: Personal
Function.Flight Crew: Pilot Flying
Function.Flight Crew: Single Pilot
Qualification.Flight Crew: Instrument
Qualification.Flight Crew: Private
Experience.Flight Crew.Total: 900
Experience.Flight Crew.Last 90 Days: 22
Experience.Flight Crew.Type: 660
ASRS Report Number: 1194004

Events
Anomaly.Inflight Event / Encounter: Other / Unknown
Detector.Person: Flight Crew
Result.Flight Crew: Took Evasive Action

Assessments
Contributing Factors / Situations: Environment - Non Weather Related
Primary Problem: Environment - Non Weather Related

Narrative 1
The Ivanpah Solar Power Plant glare caused cockpit illumination. The glare makes scanning for traffic impossible over approximately 40 degrees of the horizon which is directly ahead of the aircraft, approaching BOACH Intersection, on V21. To avoid eye discomfort the pilot had to lower his viewpoint in the aircraft to place the power plant mirrors below the glareshield.

Synopsis
M20 pilot reports the glare from a Solar Power Plant requires the pilot seat to be lowered so the glareshield blocks the mirrors, but also eliminates the view forward.

ACN: 1194022

Time
Date: 201407
Local Time Of Day: 0601-1200

Place
Locale Reference.ATC Facility: ZLA.ARTCC
State Reference: CA
Altitude.MSL.Single Value: 10000

Environment
Flight Conditions: VMC
Light: Daylight

Aircraft 1
ATC / Advisory.Center: ZLA
Aircraft Operator: Personal
Make Model Name: M-20 J (201) / Allegro
Operating Under FAR Part: Part 91
Flight Phase: Cruise

Person 1
Reporter Organization: Personal
Function.Flight Crew: Pilot Flying
Function.Flight Crew: Single Pilot
Qualification.Flight Crew: Instrument
Qualification.Flight Crew: Private
Experience.Flight Crew.Total: 900
Experience.Flight Crew.Last 90 Days: 25
Experience.Flight Crew.Type: 650
ASRS Report Number: 1194022

Events
Anomaly.Inflight Event / Encounter: Other / Unknown
Detector.Person: Flight Crew
Result.Flight Crew: Took Evasive Action

Assessments
Contributing Factors / Situations: Environment - Non Weather Related
Contributing Factors / Situations: Human Factors
Primary Problem: Environment - Non Weather Related

Narrative 1
The Ivanpah Solar Power Plant glare caused cockpit illumination. The glare makes scanning for traffic impossible over approximately 40 degrees of the horizon which is directly ahead of the aircraft, approaching WHIGG Intersection, on V21. To avoid eye discomfort the pilot had to lower his view point in the aircraft to place the power plant mirrors below the glareshield.

Synopsis
M20 pilot reports the glare from a Solar Power Plant requires the pilot seat to be lowered so the glareshield blocks the mirrors, but also eliminates the view forward.

Adams, Jim@Energy

From: CONNELL, LINDA (ARC-TH) [linda.j.connell@nasa.gov]
Sent: Friday, October 17, 2014 3:36 PM
To: Rex.MacLean@faa.gov
Cc: Adams, Jim@Energy; Brian.J.Johnson@faa.gov; Ian.Gregor@faa.gov
Subject: Re: NASA ASRS Reports on Solar Glare
Attachments: 9 - Sept 2014 Solar Plant Glare Incident 1205014.pdf

Rex,
Here is the latest report we have received.
Thanks
Linda

From: <CONNELL>, Linda Connell <linda.j.connell@nasa.gov>
Date: Thursday, October 9, 2014 4:41 PM
To: "Rex.MacLean@faa.gov" <Rex.MacLean@faa.gov>
Cc: "Adams, Jim@Energy" <Jim.Adams@energy.ca.gov>, "Brian.J.Johnson@faa.gov" <Brian.J.Johnson@faa.gov>, "Ian.Gregor@faa.gov" <Ian.Gregor@faa.gov>
Subject: NASA ASRS Reports on Solar Glare

Rex,
We have received one more report here Sept 23 and are preparing it for distribution. However, I wanted to put in one file the total number of reports we have already sent to you and the others. There are 8 reports total (See attached file). Each report has a number on the top – ACN #. These are consecutive for date they were received and unique identifiers for the event. If you check the previous reports you have received, we believe these will be duplicate to those. Two of the eight were included in the two Alerts/FYI that we sent out.

As soon as this new report is available, I will send to you.
Regards,
Linda

Linda Connell, NASA ASRS Director
NASA Ames Research Center
Moffett Field, CA 94035-0001

ASRS Director Office (408) 541-2827
ASRS Main Office (408) 541-2802
Cell (650) 207-2744

ATTACHMENT 13

ACN: 1205014

Time

Date: 201409

Local Time Of Day: 1201-1800

Place

Locale Reference.ATC Facility: ZLA.ARTCC

State Reference: CA

Altitude.MSL.Single Value: 9500

Environment

Flight Conditions: VMC

Aircraft 1

ATC / Advisory.Center: ZLA

Make Model Name: Cessna Aircraft Undifferentiated or Other Model

Person 1

Function.Flight Crew: Pilot Flying

Function.Flight Crew: Single Pilot

ASRS Report Number: 1205014

Events

Anomaly.Inflight Event / Encounter: Other / Unknown

Detector.Person: Flight Crew

Result.General: Physical Injury / Incapacitation

Narrative 1

The pilot and crew approached the Solar Generating Station located south of Las Vegas, NV. Pilot noted the NOTAMs issued about the facility. The light generated from the station was blinding to both pilot and crew. The bright light was almost blinding from a distance of 20 plus miles. This facility generates three bright lights on a 360 degree arc around the facilities. The light from the facility was very similar to that seen when looking at a welder. One crew member complained they only looked at it briefly and felt it hurt their eyes in a manner similar to that caused by snow blindness. All crew-members were wearing sunglasses which did not appear to reduce the glare.

The pilot and crew-members agree with language in the NOTAMs that this facility poses hazards to aviation and passengers. On the previous day the same pilot and crew flew a similar mission near the Solar Generating Station near Coalinga, CA. The generating station there is smaller and the reflectors are one directional which reflect the bright light toward the north. It does not appear to be as hazardous because of the mono directional characteristic and it is not on any obvious approach paths to major airports.

Callback 1

The effect on human vision was reported to be painful and disabling.

Synopsis

A small aircraft flight crew flew at 9,500 FT near the Solar Generating Station and experienced a light similar to a welder's arc, which reflected from the tower itself was blinding 360 degrees for twenty miles.

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March 28, 2014

Joseph Douglas, Compliance Project Manager
California Energy Commission
Siting, Transportation, and Environmental Protection Division
1516 9th Street
Sacramento, CA 95814

RE: Heliostat Positioning Plan (HPP) and Power Tower Luminance Plan (PTLP)

Dear Mr. Douglas:

The Ivanpah Solar Electric Generating System (ISEGS) is providing this letter to update the California Energy Commission regarding the status of activities related to the Conditions of Certification (CoC) TRANS-3 and TRANS-4. Please note that the plans required by these certifications were approved by Commission staff in December of 2013.

Prior to approval of these plans, the operational staff at the facility commenced a review process to identify and obtain suitable consulting services to provide the required surveys described in the plans associated with CoC TRANS-3 and TRANS-4. The review of potential candidates indicated that unparalleled expertise resided at Sandia National Laboratory. Specifically, the ISEGS team determined that Dr. Clifford Ho, who is recognized as a leading expert in the field, would be a superior candidate to retain for this project.

ISEGS has diligently pursued a contract with Sandia National Laboratories. ISEGS is pleased to report that the facility and the laboratory have executed a contract for services. As a result, Dr. Ho will now be assisting the facility with activities related to TRANS-3 and TRANS-4. Dr. Ho will commence field surveys next month at the facility. Following the field surveys, a report will be prepared. This report is anticipated to be available in May.

In addition to a written report, Dr. Ho will also prepare a presentation of the results. The ISEGS team has also included in Dr. Ho's scope of work a presentation to agency personnel. As a result, ISEGS would like to schedule a meeting with the appropriate CEC staff to review the findings of the surveys.

ATTACHMENT 14

ISEGS appreciates the continuing cooperation of the Commission staff. Please feel free to contact me regarding scheduling a meeting to review the result of the aforementioned surveys. Please update your files to reflect the new contact information.

Sincerely,

Shankara Babu

Shankara Babu PhD, CHMM, CEM
ESH manager
Ivanpah Solar Thermal
100302 Yates Well Road
Nipton, CA 92364
Office: (702)815-2012

CC:

Raymond C. Lee, Field Manager
Michael W. Ahrens, Acting Field Manager
Bureau of Land Management
Needles Field Office
1303 South Highway 95
Needles, CA 95814

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an NRG service

April 29, 2014

Joseph Douglas, Compliance Project Manager
California Energy Commission
Siting, Transportation and Environmental Protection Division
1516 9th Street
Sacramento, CA 95814

RE: Response to ACN: 1156120

Dear Mr. Douglas:

The Ivanpah Solar Electric Generation System (ISEGS) is providing this letter to the California Energy Commission (CEC) in compliance with Condition of Certification (CoC) TRANS-3 and Section 6.5 of the Heliostat Positioning Plan (HPP). The HPP requires that ISEGS address complaints as soon as practicable and report the results. This letter is in response to the email sent to Mr. Doug Davis on April 16, 2014 from Joe Douglas of the CEC. A pilot report was attached to this email (RE: ACN: 1156120).

In accordance with the HPP, Dr. Clifford Ho of Sandia National Laboratories visited the site on April 24th and 25th to obtain measurements. Dr. Ho is currently in the process of evaluating the results of his observations and measurements. Following the analysis of the data collected, a full report will be provided. The CEC and relevant agencies identified in Section 6.5 of the Heliostat Positioning Plan will receive a copy of the report once it is complete. ISEGS will also facilitate meetings with Dr. Ho to review the results of his work.

ISEGS appreciates the continuing cooperation of the Commission staff. Please feel free to contact me directly should you have any questions.

Sincerely,

Shankara Babu PhD, CHMM, CEM
ESH Manger

Ivanpah Solar Thermal
100302 Yates Well Road
Nipton, CA 92364
Office: (702)815-2012

CC: Michael W. Ahrens, BLM Field Manager

ATTACHMENT 15

Adams, Jim@Energy

From: Ho, Clifford K [ckho@sandia.gov]
Sent: Friday, July 25, 2014 11:51 AM
To: Adams, Jim@Energy
Cc: Ho, Clifford K
Subject: Glare Evaluation of Ivanpah Solar Electric Generating System

Hi Jim,

Thanks for your call today (I also received a voice mail from Dave Flores yesterday). Per your request, I am writing this e-mail to summarize recent activities I have participated in pertaining to glare evaluations at the Ivanpah Solar Electric Generating System (ISEGS).

As you know, Sandia conducted aerial (helicopter) and ground-based surveys of the glare at ISEGS on April 24 – 25, 2014, and we published a report on our findings in July ("Evaluation of Glare at the Ivanpah Solar Electric Generating System," SAND2014-15847). In that report, we presented quantification of the observed glare (e.g., irradiance, subtended angle), potential ocular impacts, and possible mitigation measures. By the way, I noticed that the report was docketed by the CEC with a cover page title of "Heliostat Positioning Plan Report," which may be confusing since there are other previous ISEGS documents titled "Heliostat Positioning Plan."

As a result of the findings in the report and discussions with NRG (Doug Davis, Mitch Samuelian) and Brightsource (Gustavo Buhacoff, Gil Kroyzer, Nitzan Goldberg), Brightsource modified the heliostat standby algorithm for Units 1 and 2 to spread out the ring of aim points. The objective was, in part, to reduce the potential ocular impacts of the glare from the heliostats in standby mode.

On July 22, I performed another aerial survey in a helicopter to observe the glare after the implemented changes. I found that there was still glare visible from all the units as we circled around the site, but there were noticeable differences in the glare from Units 1 and 2. The source of the glare from the heliostats in standby mode were more spread out. In addition, I noted that the glare was more pronounced when we were located to the south of ISEGS. When we were to the north, east, and west of the plant, the glare was not as significant; the reason may be that fewer heliostats were in standby mode in different regions to accommodate the time of day and position of the sun (I took images close to noon on July 22). I have not had an opportunity to process and quantify the numerous images I took of the glare from all the units that day, but I plan to do so over the next few weeks. The pilot, myself, and another passenger noted that, while bright, the glare that was visible did not appear to produce an after-image while wearing sunglasses when viewed momentarily. However, if I took my sunglasses off and looked directly into the glare, I did notice a temporary after-image. I believe that with further modification of the heliostat standby algorithm, the impact of the glare from heliostats in standby mode can be further reduced or mitigated. I recently spoke with Gustavo from Brightsource, and he said that he had some additional ideas that he would try to implement to further mitigate the impacts of glare.

I think it would be best to meet to discuss these issues and possible mitigation methods. I have spoken with NRG and Brightsource, and they are both interested in having a workshop with the CEC and other interested parties to discuss and address issues regarding glint and glare at ISEGS.

Please let me know if you have any questions, and please provide details of the hearing on Tuesday regarding the Palen plant so that I can call in as you requested.

Best regards,

-Cliff Ho

ATTACHMENT 16

Cliff Ho, Ph.D.
Concentrating Solar Technologies
Sandia National Laboratories
P.O. Box 5800, MS-1127
Albuquerque, NM 87185
(505) 844-2384
ckho@sandia.gov
www.sandia.gov/csp

Evaluation of Glare at the Ivanpah Solar Electric Generating System – 2nd Flyover on July 22, 2014

Clifford K. Ho
Sandia National Laboratories
Concentrating Solar Technologies Dept.
Albuquerque, New Mexico
ckho@sandia.gov, (505) 844-2384

SAND2014-17265 PE

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Exceptional service in the national interest

Sandia National Laboratories

ATTACHMENT 17

Overview

Sandia National Laboratories

- Background and Objectives
- Aerial Glare Monitoring
- Next Steps

Ivanpah Solar Electric Generating System

Sandia National Laboratories

- Three power tower units (377 MW (net) / 392 MW (gross)
  - Unit 1: 126 MW
  - Unit 2: 133 MW
  - Unit 3: 133 MW
  - Each tower 140 m (459 ft) tall
- 173,500 heliostats
  - 2 mirrors/heliostat: 15.2 m^2
- Direct steam receiver (22 m tall x 17 m wide + ~16 m of white shielding)
- Dry-cooling
- 14.2 km^2 (3500 acres) on public desert land in southern California
- Owners: NRG Energy, Google, and Brightsource Energy

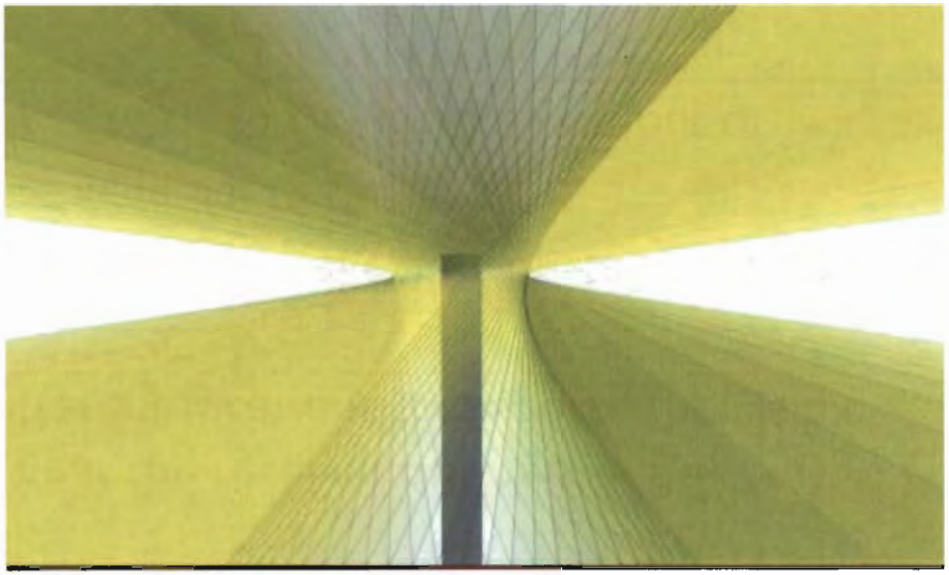
Previous Aerial Surveys of Glare

Sandia National Laboratories

- April 24, 2014 – Sandia National Laboratories
  - Heliostats in standby mode can cause glare to aerial observers
  - Glare from heliostats can cause after-image at far distances (up to 6 miles in our helicopter surveys); similar to briefly looking at sun
  - Glare was visible from multiple heliostats in standby mode
  - The glare from the illuminated receiver was small compared to the glare from the standby heliostats
  - Ground-based drive-by surveys did not reveal ocular hazards
  - Suggested mitigations measures for heliostats in standby mode
- May 8, 2014 – CEC Staff and Contractors
  - Observed glare from "direct solar reflections from the heliostats (DSRH)" in standby mode that were sufficient to result in "disability glare" that can compromise visual performance and flight safety
  - Suggested mitigation measures for heliostats in standby mode

Glare from Heliostats in Standby Mode

Sandia National Laboratories



Suggested Mitigation Measures

Sandia National Laboratories

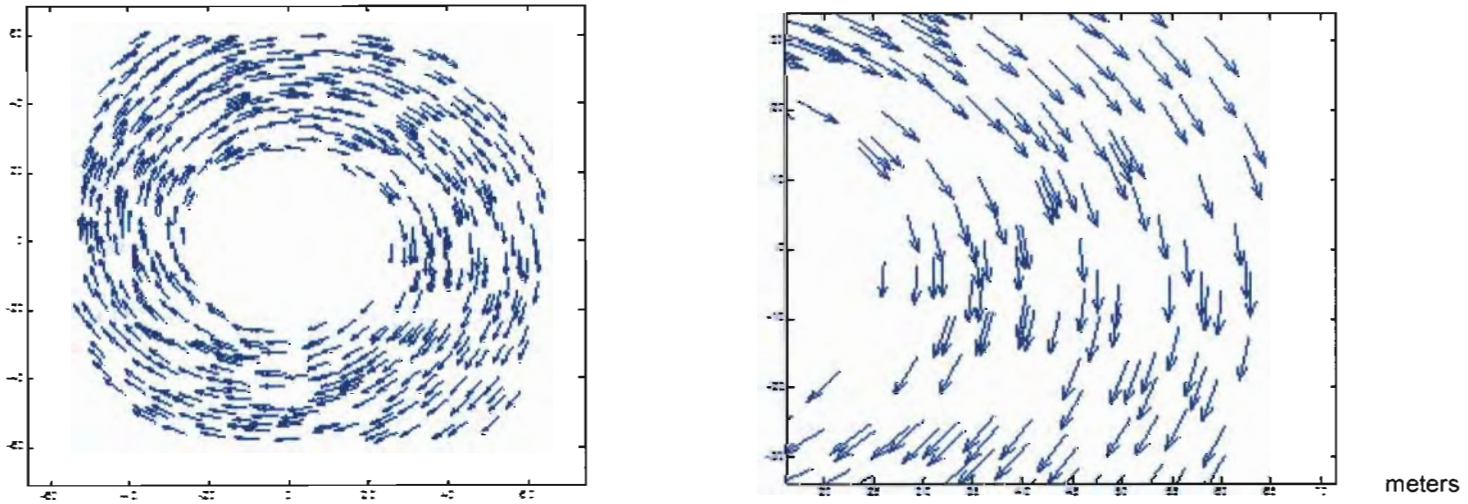
- Limit the number of heliostats in standby mode
  - Predict need for standby heliostats based on cloud cover or other factors
  - Position some heliostats vertically in proper azimuth position to reduce time to slew to target
  - Bring heliostats up to standby position near receiver sequentially only as needed
- Increase the number of aim points near the receiver during standby and have adjacent heliostats point to different locations to disperse the visible glare
- Incorporate a glare shield near the receiver for heliostats in standby mode
  - Perhaps the shield can serve as a preheater for the water
- Improve tracking and positioning algorithms to reduce the number of "rogue" heliostats

Heliostat Standby Aiming Strategies

(Personal communication – Nitzan Goldberg, Brightsource Energy, 7/22/14)

Sandia National Laboratories

- Option 1 (original)
  - Standby points are as close to the receiver as possible
  - Each heliostat as its own aim point depending on azimuth and distance
  - Each heliostat aims to the left side of the receiver

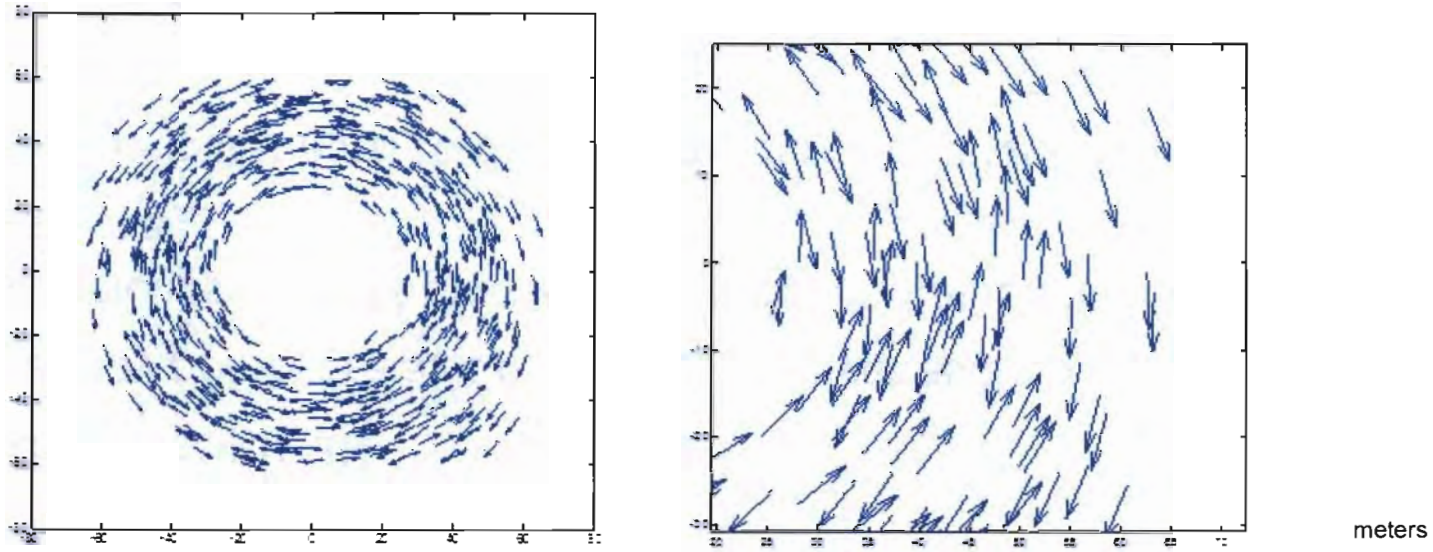


Quiver plots showing flux vectors near the receiver from a sample of heliostats for Option 1

Heliostat Standby Aiming Strategies

(Personal communication – Nitzan Goldberg, Brightsource Energy, 7/22/14)

- Option 2 (Unit 1 during April 24 flyover?)
  - Standby points are as close to the receiver as possible
  - Each heliostat as its own aim point depending on azimuth and distance
  - Aiming is to both sides of the receiver



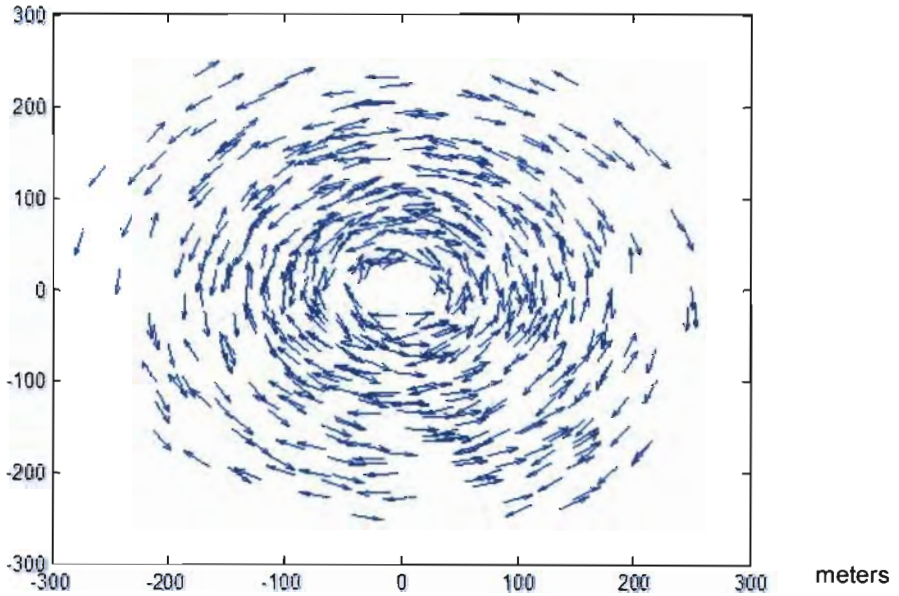
Quiver plots showing flux vectors near the receiver from a sample of heliostats for Option 2

Heliostat Standby Aiming Strategies

(Personal communication – Nitzan Goldberg, Brightsource Energy, 7/22/14)

Sandia National Laboratories

- Option 3 (Units 1 and 2 during July 22 flyover)
  - Spread standby points to reduce flux density in air around receiver and to disperse the observable glare
  - Aiming is to both sides of the receiver



Quiver plots showing flux vectors near the receiver from a sample of heliostats for Option 3

Objective

Sandia National Laboratories

- Sandia performed a second aerial survey on July 22, 2014
  - First aerial survey was performed on April 24, 2014
- Objective was to evaluate impact of changes made to standby aiming strategies employed at Units 1 and 2 (Unit 3 was unchanged)
  - Units 1 and 2 employed standby aiming strategy similar to Option 3
  - Unit 3 employed standby aiming strategy similar to Option 1

Overview

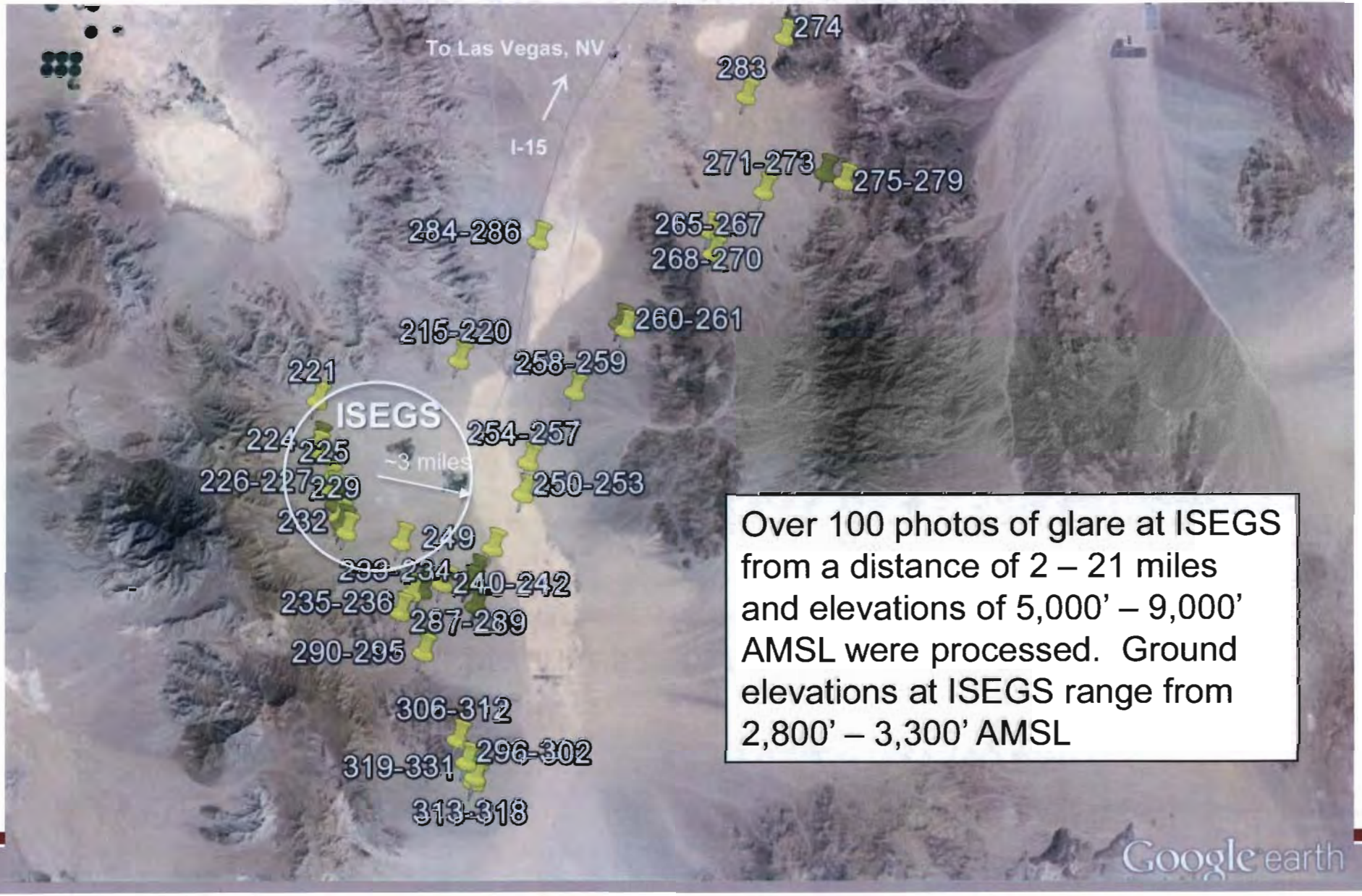
Sandia National Laboratories

- Background and Objectives
- Aerial Glare Monitoring
- Next Steps

Aerial Monitoring Photo Locations

July 22, 2014 (~11:00 AM – 12:50 PM)

Sandia National Laboratories



Over 100 photos of glare at ISEGS from a distance of 2 – 21 miles and elevations of 5,000' – 9,000' AMSL were processed. Ground elevations at ISEGS range from 2,800' – 3,300' AMSL

Aerial Glare Photographs

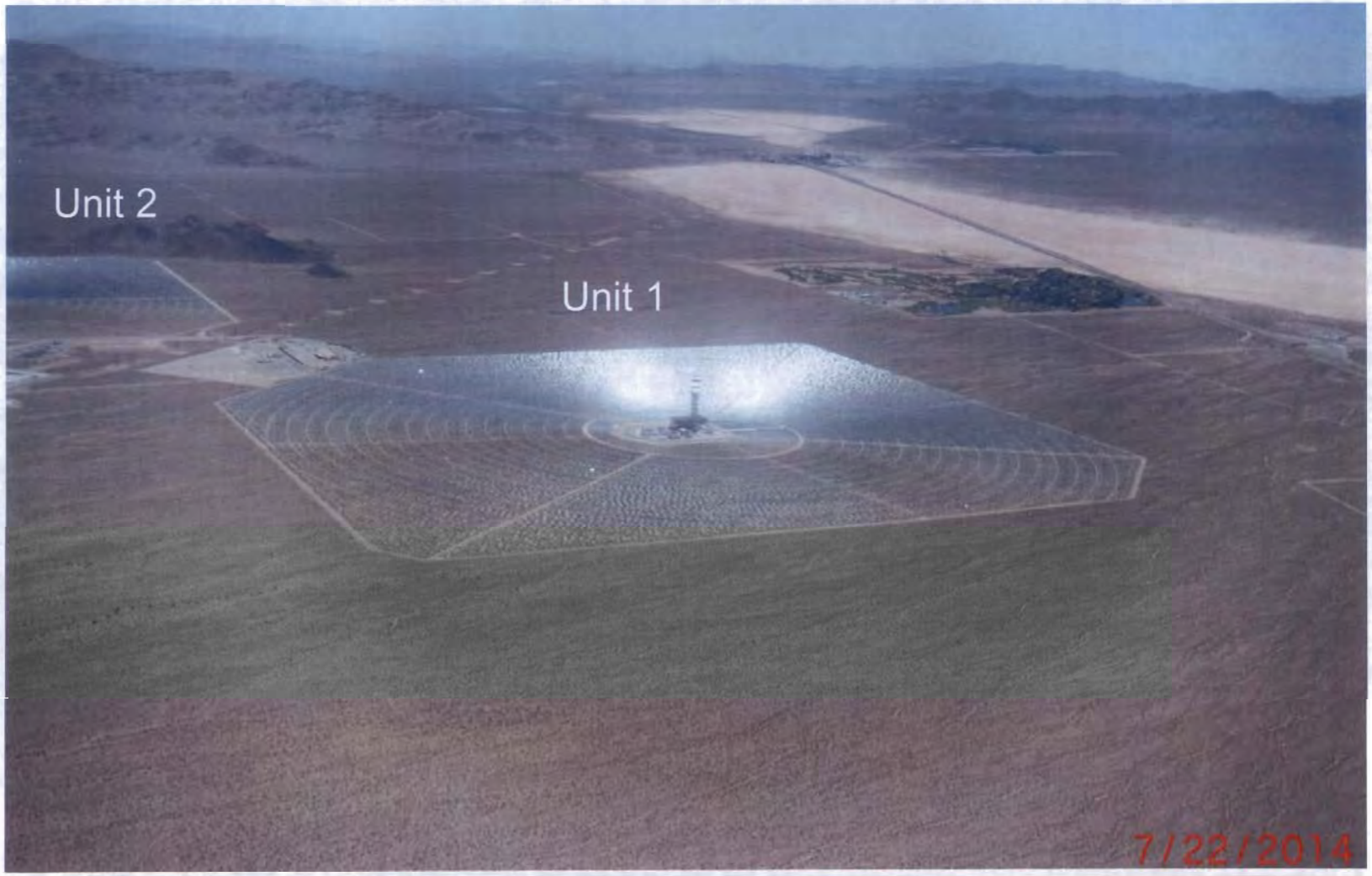
Sandia National Laboratories

Looking Southeast, ~1 – 4 miles away
11:20 AM (PDT), July 22, 2014

Aerial Glare Photographs

Sandia National Laboratories

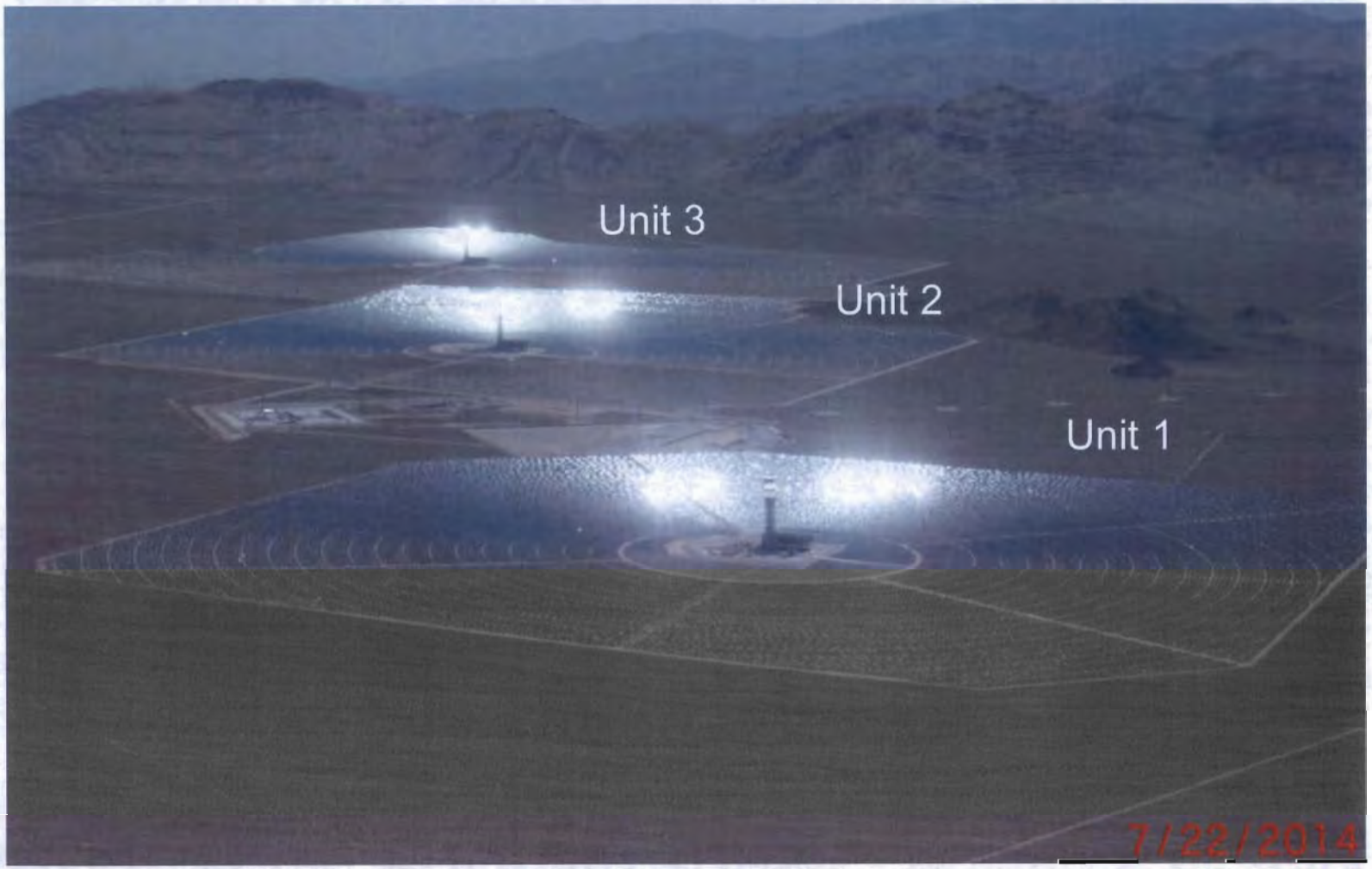
Looking Northeast, ~2 – 3 miles away
11:29 AM (PDT), July 22, 2014



Aerial Glare Photographs

Sandia National Laboratories

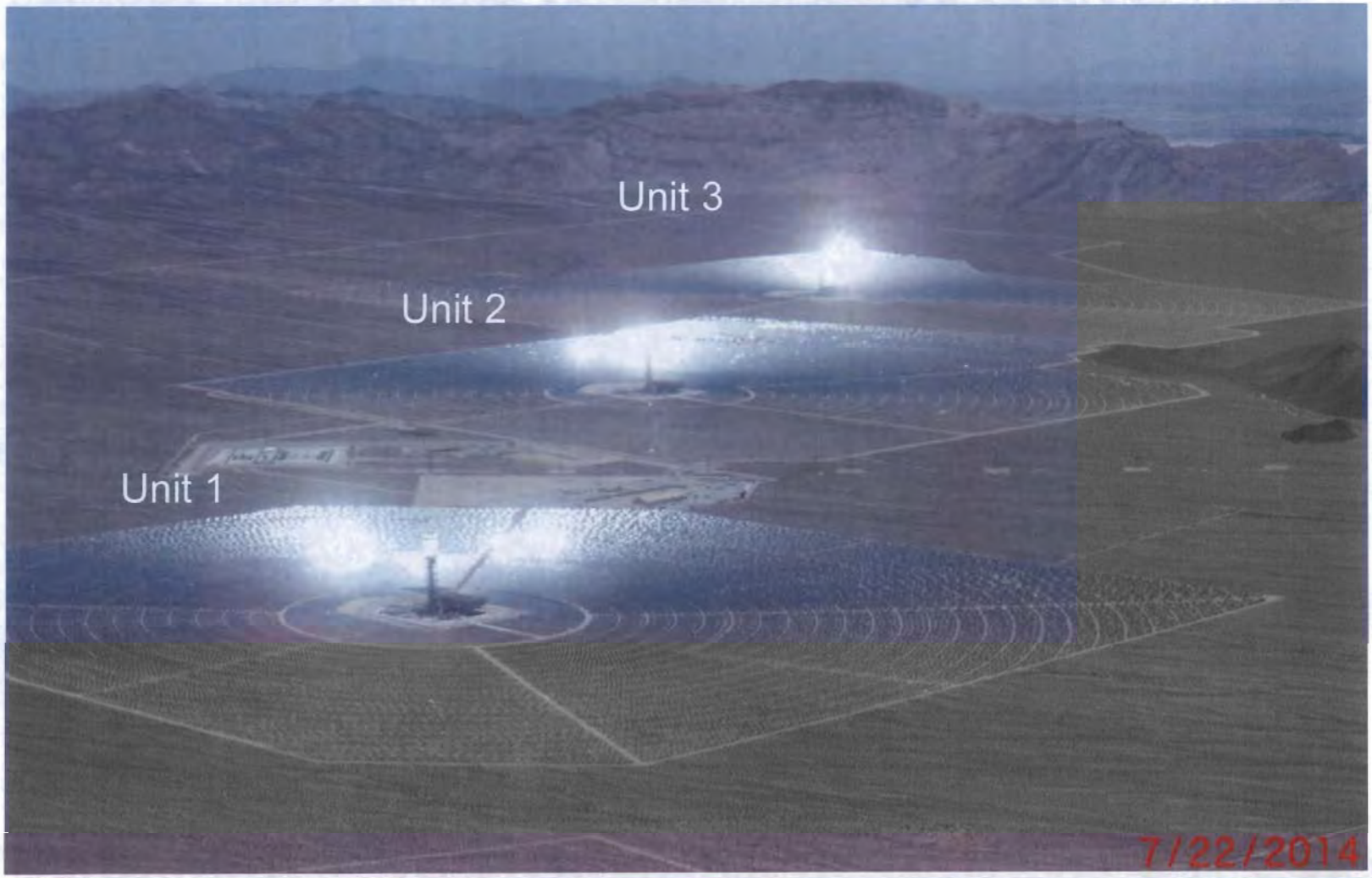
Looking North/Northwest, ~5 – 6 miles away
11:33 AM (PDT), July 22, 2014



Aerial Glare Photographs

Sandia National Laboratories

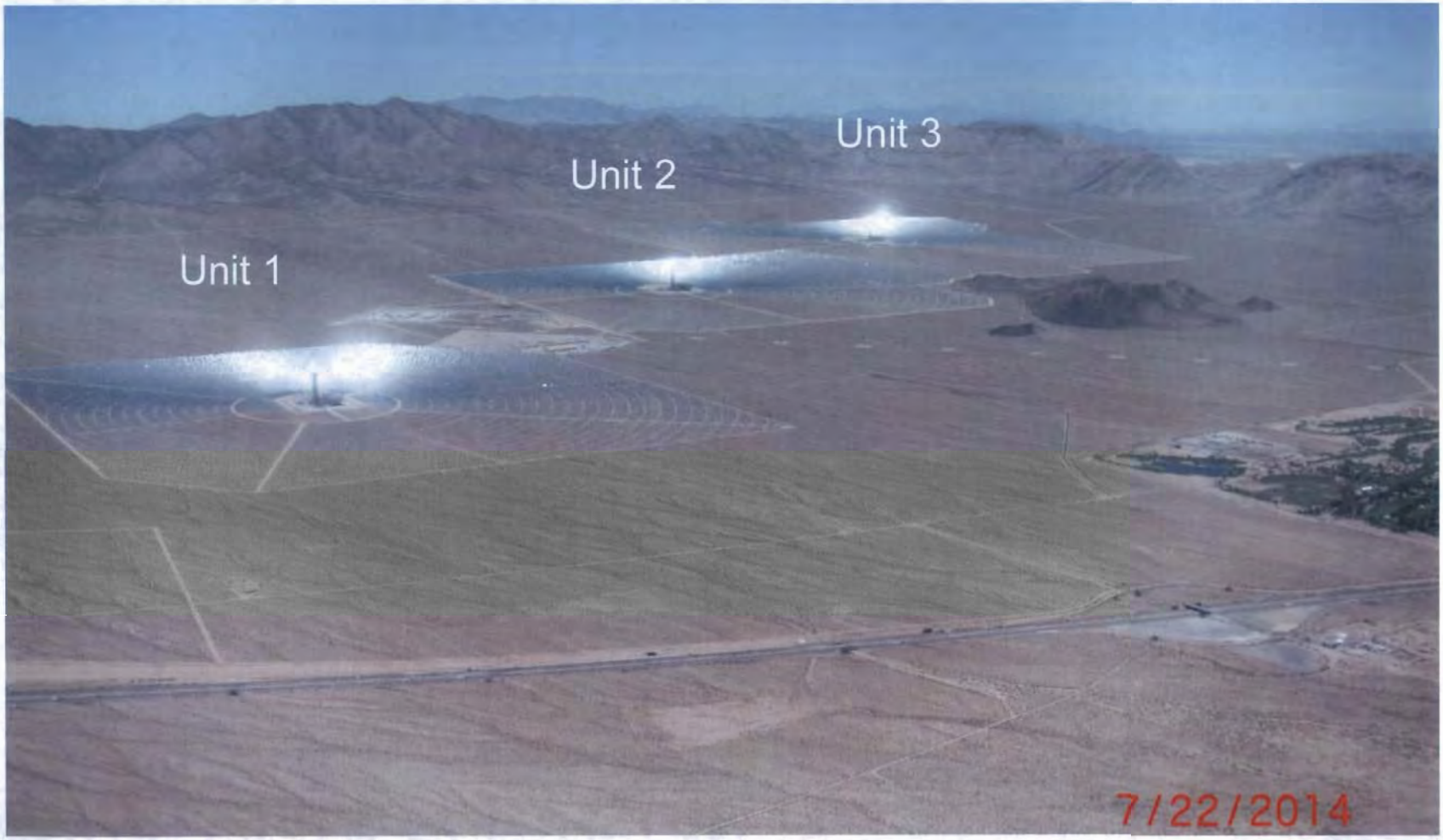
Looking Northwest, ~3 – 5 miles away
11:38 AM (PDT), July 22, 2014



Aerial Glare Photographs

Sandia National Laboratories

Looking West/Northwest, ~5 – 6 miles away
11:40 AM (PDT), July 22, 2014



Aerial Glare Photographs

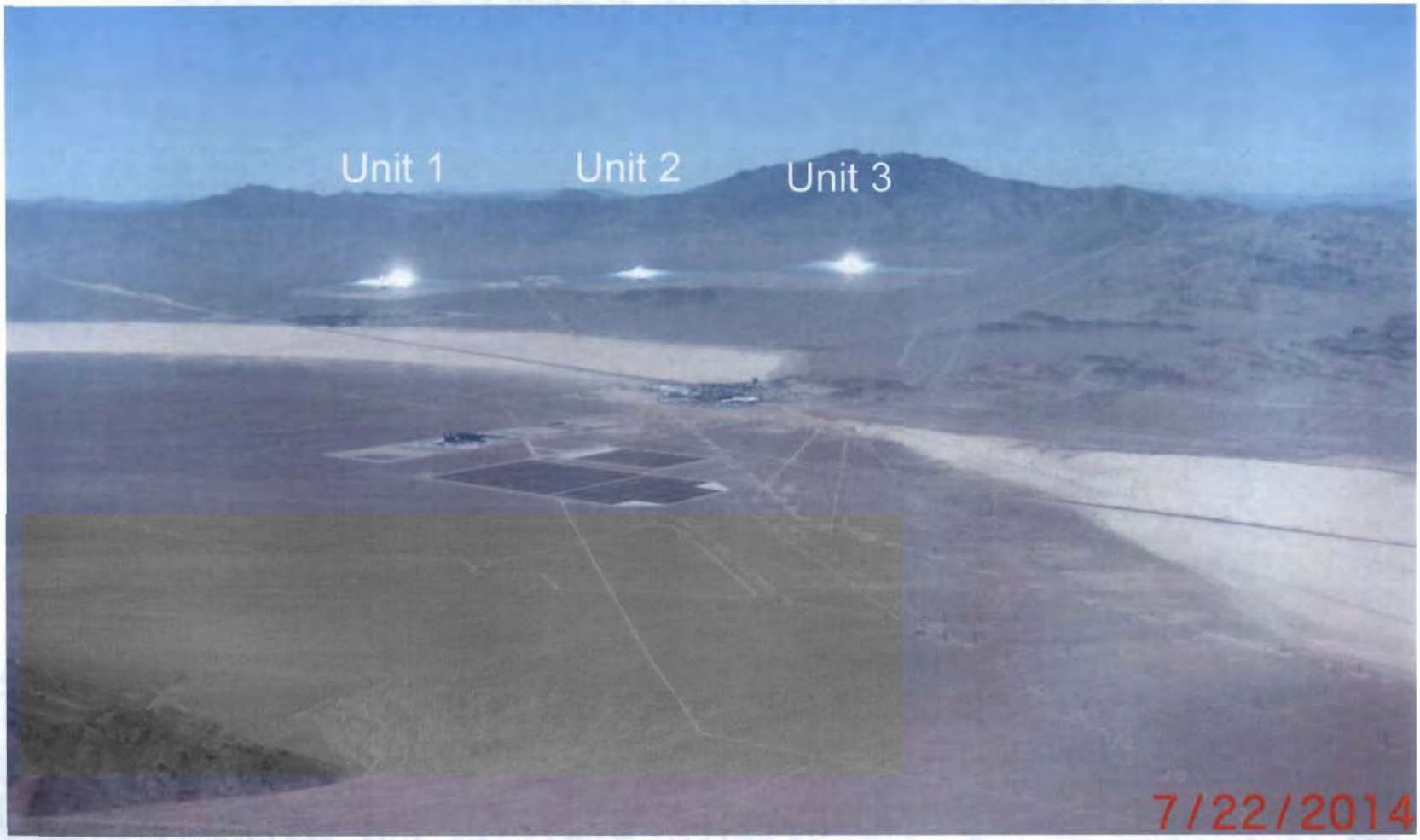
Sandia National Laboratories

Looking West/Southwest, ~7 – 8 miles away
11:48 AM (PDT), July 22, 2014

Aerial Glare Photographs

Sandia National Laboratories

Looking Southwest, ~16 – 17 miles away
12:00 PM (PDT), July 22, 2014



Aerial Glare Photographs

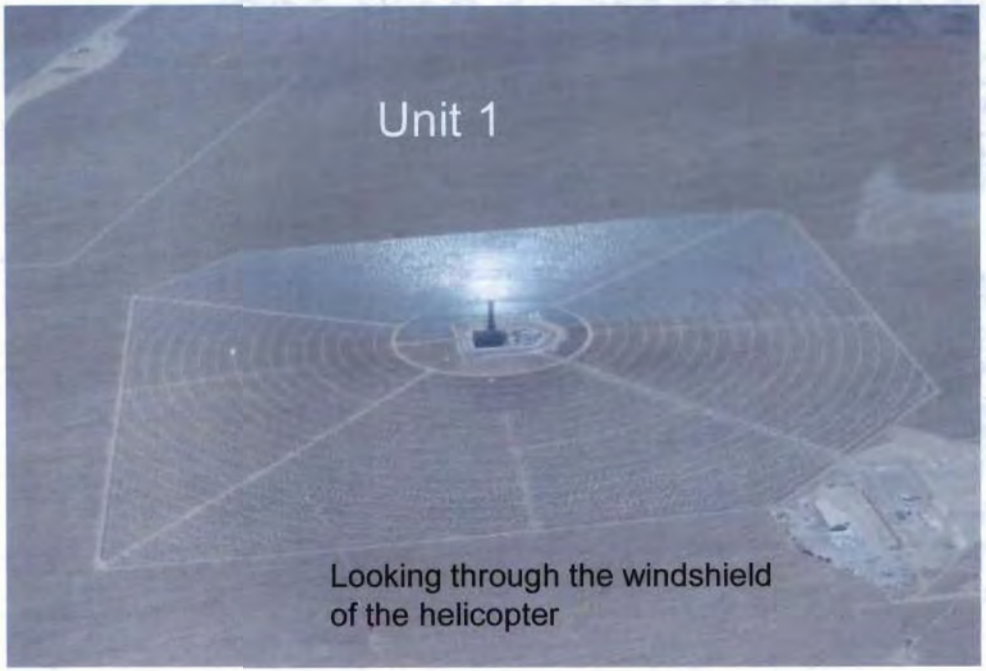
Sandia National Laboratories

Looking South/Southwest, ~9 – 10 miles away
12:17 PM (PDT), July 22, 2014

Aerial Glare Photographs

Sandia National Laboratories

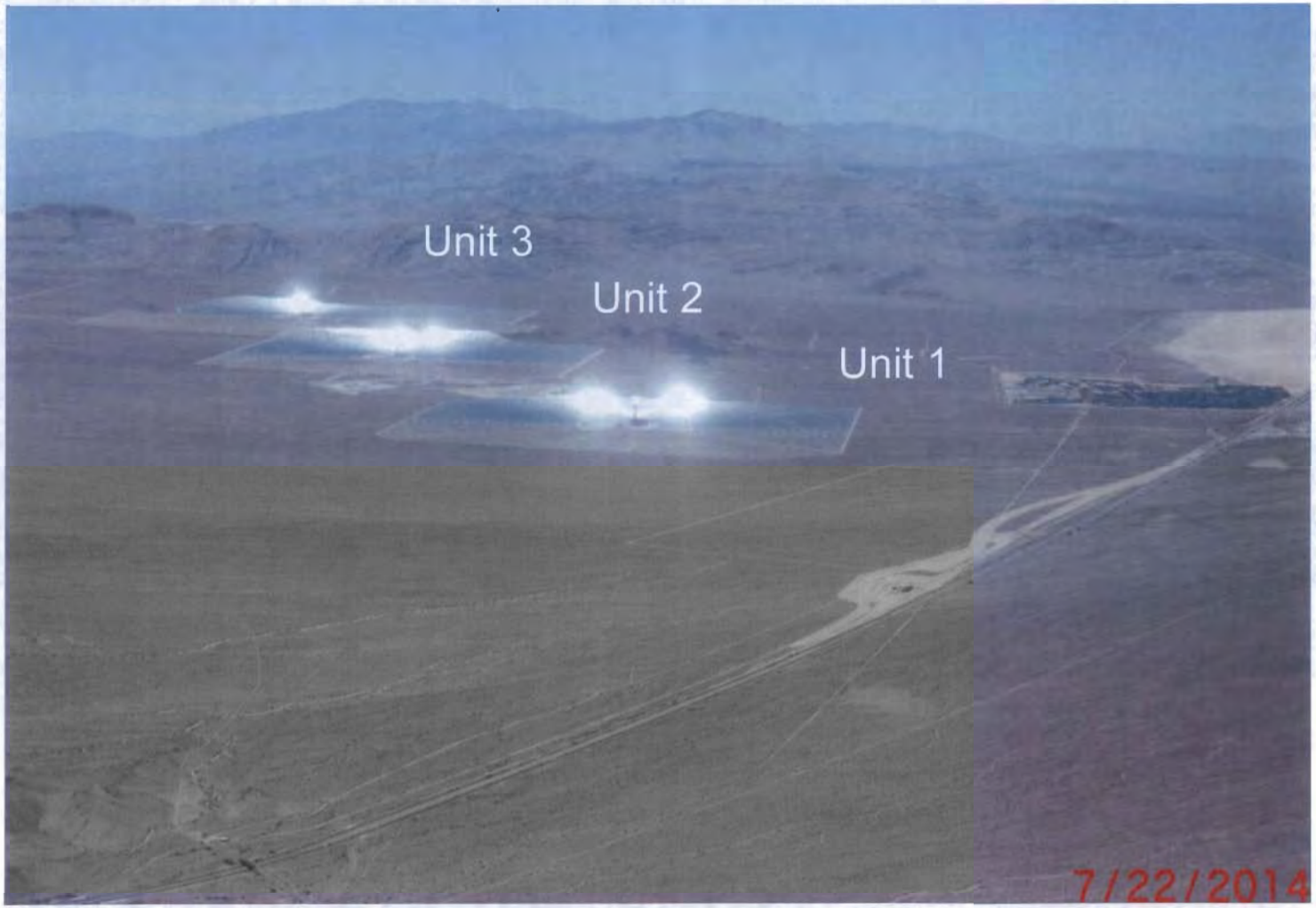
Looking South, ~1 – 2 miles away
12:21 PM (PDT), July 22, 2014



Aerial Glare Photographs

Sandia National Laboratories

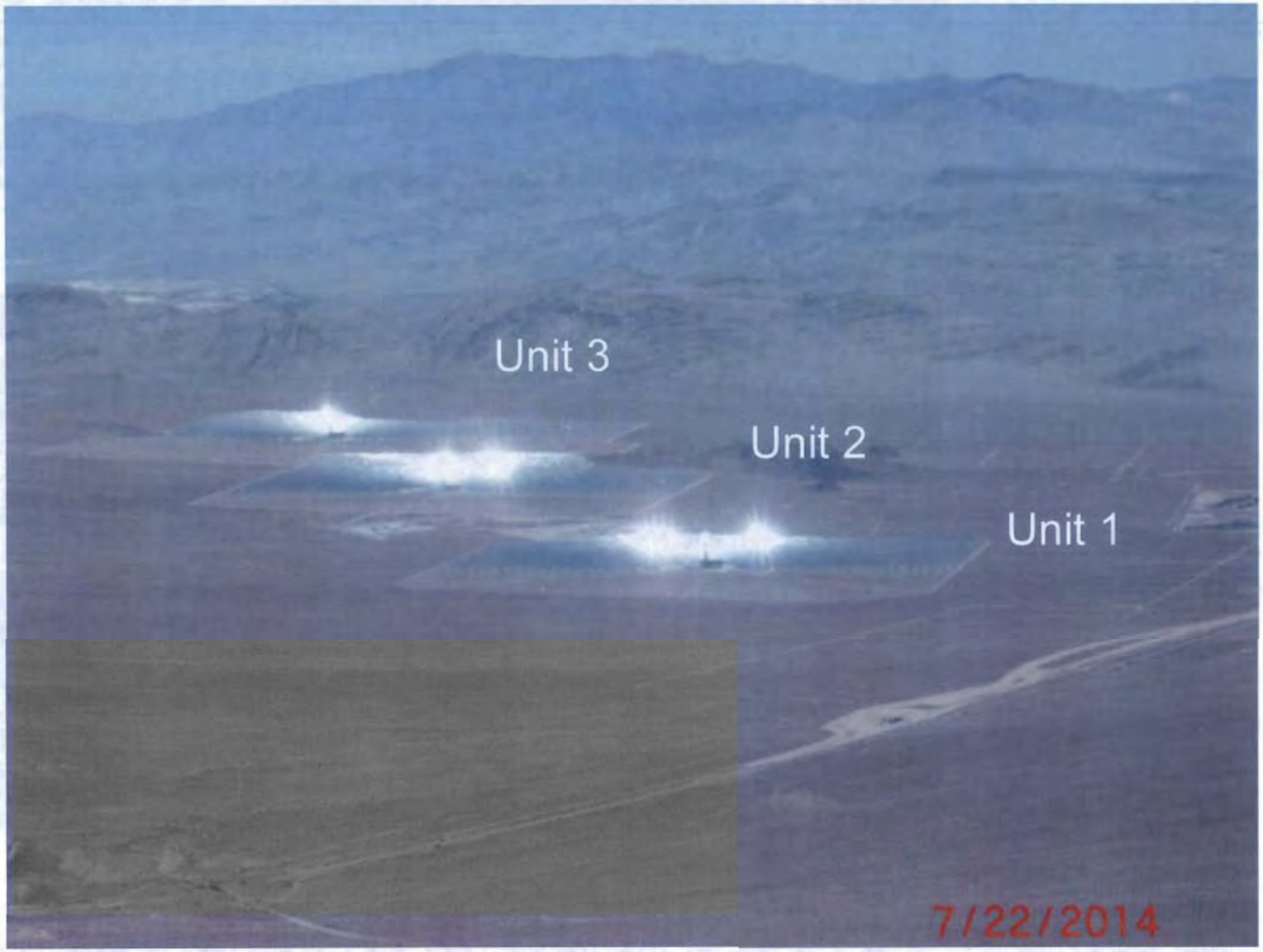
Looking North/Northwest, ~6 – 9 miles away
12:31 PM (PDT), July 22, 2014



Aerial Glare Photographs

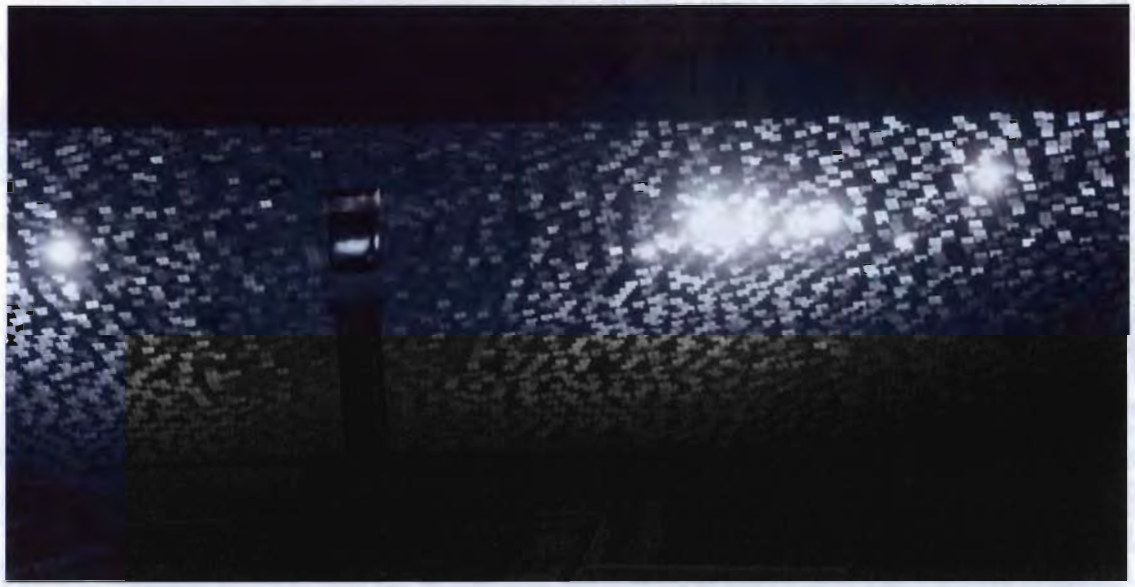
Sandia National Laboratories

Looking North/Northwest, ~7 – 10 miles away
12:40 PM (PDT), July 22, 2014



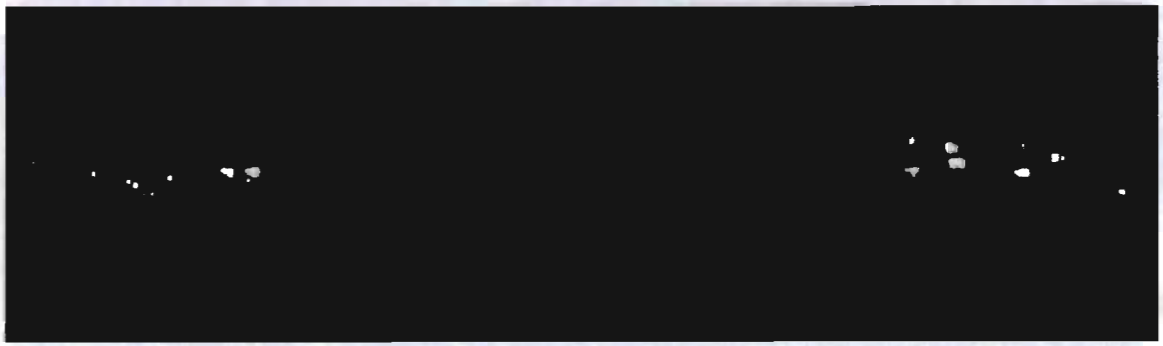
Unit 1 – Looking North/Northwest ~3 – 4 miles away

Sandia National Laboratories



~11:31 AM (PDT)

DSC237 (no filters),
1/3200s – f/32
Brightest points are saturated



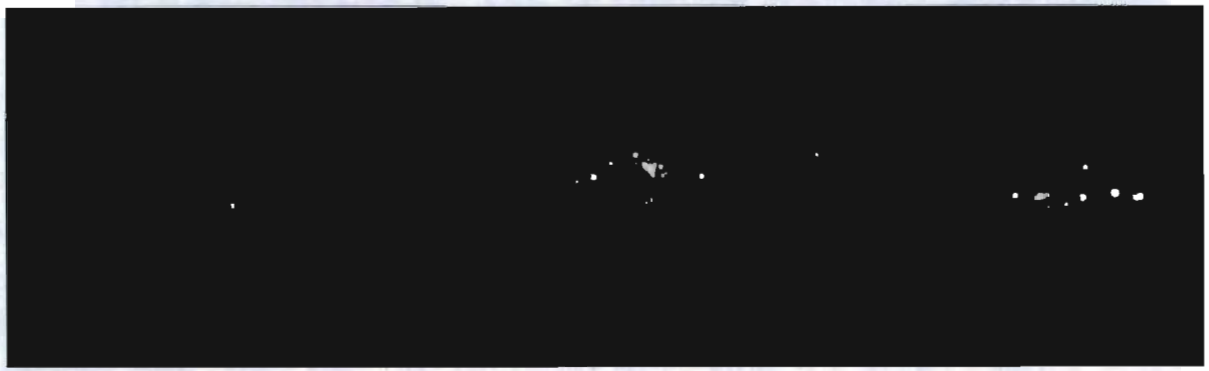
DSC235 (~60X filtering),
1/3200s – f/32
No saturation

Unit 2 – Looking North/Northwest ~5 miles away

Sandia National Laboratories

~11:30 AM (PDT)

DSC238 (no filters),
1/3200s – f/32
Brightest points are saturated



DSC236 (~60X filtering),
1/3200s – f/32
No saturation

Unit 3 – Looking North/Northwest, ~7 miles away

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~11:32 AM (PDT)
DSC239 (no filters), 1/3200s – f/32
Brightest points are saturated

~11:38 AM (PDT)
DSC246 (~4096X filter), 1/3200s – f/32
No saturation

Ocular Hazard Analysis

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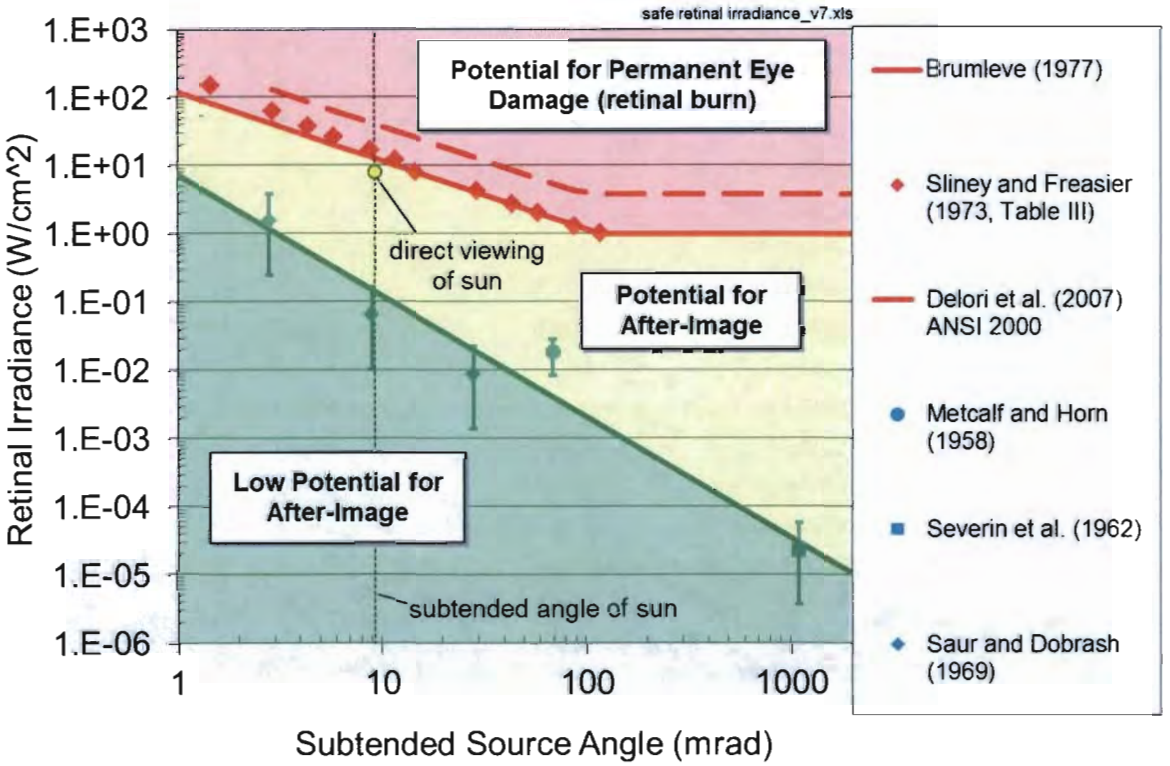
- Use image of sun and DNI to scale irradiance and subtended angle of glare from heliostats



From Ho et. al (2011)

Ocular Hazard Analysis

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Sampling from over 100 glare images

Image	DNI (W/m^2)	Tower Unit	Approximate Distance to Glare Source (miles)	Average Retinal Irradiance (W/cm^2)	Total Subtended Glare Angle (mrad)	Ocular Impact
DSC 0233	1000	1	1.9	2.118	1.024	Low Potential for After-Image
DSC 0221	1000	3	2.4	0.810	0.976	Low Potential for After-Image
DSC 0224	1000	2	2.8	0.137	0.489	Low Potential for After-Image
DSC 0229	1000	1	3	1.766	1.428	Low Potential for After-Image
DSC 0250	1000	1	4.2	2.518	1.054	Low Potential for After-Image
DSC 0218	1000	3	4.5	2.037	0.685	Low Potential for After-Image
DSC 0240	1000	2	5.2	1.450	1.158	Low Potential for After-Image
DSC 0304	1000	2	6.5	0.985	0.777	Low Potential for After-Image
DSC 0252	1000	3	6.6	1.751	0.492	Low Potential for After-Image
DSC 0258	1000	1	7.2	1.493	1.221	Low Potential for After-Image
DSC 0289	1000	3	7.3	0.139	1.195	Low Potential for After-Image
DSC 0291	1000	2	7.3	0.137	1.101	Low Potential for After-Image
DSC 0305	1000	3	8.1	0.634	0.440	Low Potential for After-Image
DSC 0306	1000	1	8.7	0.137	2.092	Low Potential for After-Image
DSC 0285	1000	2	9.7	0.553	0.803	Low Potential for After-Image
DSC 0260	1000	1	9.9	0.821	0.498	Low Potential for After-Image
DSC 0264	1000	3	10	1.013	0.388	Low Potential for After-Image
DSC 0265	1000	1	14	0.590	0.554	Low Potential for After-Image
DSC 0271	1000	3	16.8	0.119	0.671	Low Potential for After-Image
DSC 0272	1000	1	16.9	0.110	0.384	Low Potential for After-Image
DSC 0282	1000	2	18.9	0.357	0.119	Low Potential for After-Image
DSC 0280	1000	3	19	0.467	0.320	Low Potential for After-Image
DSC 0274	1000	3	21	0.110	0.534	Low Potential for After-Image

Summary of Glare Monitoring

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- New heliostat standby aiming strategies were implemented for Units 1 and 2 ("Option 3")
  - Unit 3 was unchanged ("Option 1")
- Flyover on July 22, 2014, showed that the points of glare from Units 1 and 2 were more spread out than Unit 3
- Ocular hazard analysis showed "low potential for after-image" for all photos of Units 1, 2, and 3
  - However, I thought that the glare was still bright enough to cause complaints
  - Time of day for July 22 flyover was later (close to noon) than April 24 survey, which was ~9 AM (PDT)
- Need to consider additional standby aiming strategies and protocols

Ocular Hazard Analysis

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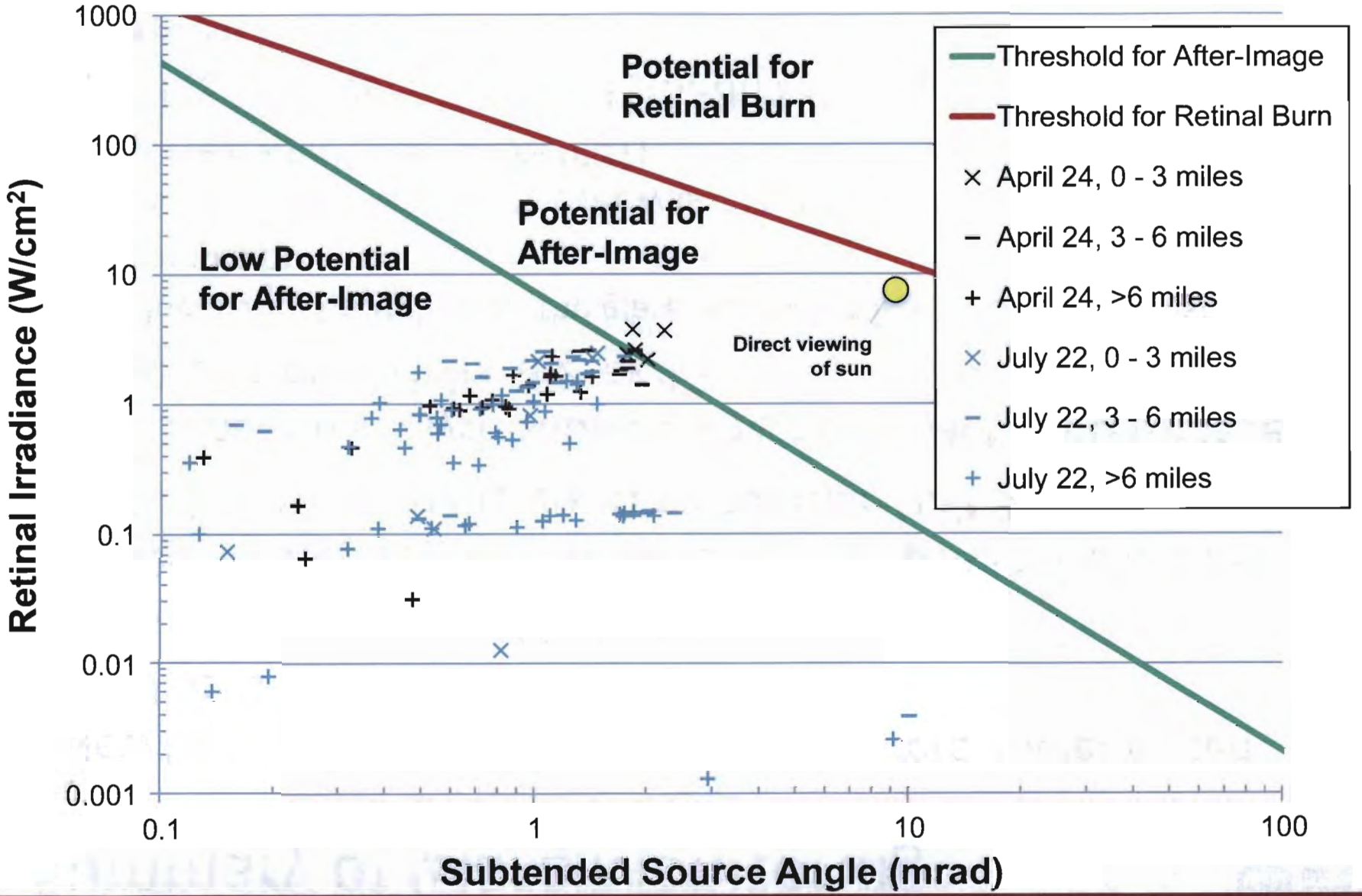

Overview

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- Background and Objectives
- Aerial Glare Monitoring
- Next Steps

Next Steps

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- Hold meeting with CEC, NRG, Brightsource, Sandia, and other stakeholders to review results and discuss path forward
  - New standby aiming strategies?
  - New standby procedures?
    - Number of heliostats in standby has been reduced (<10,000 per unit)
    - No longer bringing 100% of heliostats to standby during startup
  - Possibility of glare shields?
  - Reduce number of standby heliostats that face directly toward the sun; these produce the most glare
- Implement new aiming strategies
  - Perform additional flyovers to characterize impact
- Identify optimal solution
  - Revise Heliostat Positioning Plan for review and approval

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