Fall 2014

Evaluating Intensity as a Controller Function for NextGen Scenarios with Increased Capacity

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Graduate School Form
(Revised /)

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By Caitlin Anne Surakitbanharn

Entitled
Evaluating Intensity as a Controller Function for NextGen Scenarios with Increased Capacity

For the degree of Master of Science

Is approved by the final examining committee:

Steven J Landry

Hong Wan

Karen Marais

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Head of the Graduate Program — Date

EVALUATING INTENSITY AS A CONTROLLER FUNCTION FOR NEXTGEN SCENARIOS WITH INCREASED CAPACITY

A Thesis

Submitted to the Faculty

Of

Purdue University

By

Caitlin Anne Surakitbanharn

In Partial Fulfillment of the

Requirements for the Degree

Of

Masters of Science

December 2014

Purdue University

West Lafayette, Indiana

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ABSTRACT

Surakitbanharn, Caitlin Anne, M.S., Purdue University, December 2014. Evaluating Intensity as a Controller Function for Next Gen Scenarios with Increased Capacity. Major Professor: Dr. Steven J. Landry.

Automated separation assurance is the most mature concept to handle increasing airspace traffic and capacity needs, yet the system lacks a way to pre-emptively identify aircraft separation problems. The intensity control measure looks to find situations where if an aircraft pair makes an unplanned change in heading or altitude at the wrong moment, an unrecoverable situation arises. This research analyzes static, open loop air traffic data in an en-route sector to determine how many high intensity aircraft pairs (HIP) exist per minute, and if the intensity measure is a safely manageable function for air traffic controllers. It is found that at current, 1.5x, and 2x traffic levels, it is possible for the number of HIP to reach a manageable level of 18 pairs per minute or less. At 3x traffic, this manageable level does not occur. It is also observed that the amount of variance in HIP per minute increases as the traffic level and number of aircraft per minute increases. Adjustments to the intensity control measure and specific characteristics of air traffic at the times when 18 or less HIP are present in current, 1.5x, and 2x traffic levels may provide insight into achieving a manageable number of HIP at increased traffic levels.

CHAPTER ONE: INTRODUCTION

The most mature concept in automation separation assurance for Next Generation air traffic control (ATC) is the automated airspace concept (AAC) introduced by NASA and Erzberger (2009). However, no functionality exists to pre-emptively identify separation risks before they occur. This research aims to test whether or not the intensity control measure is a viable solution by analyzing if the number of high intensity aircraft pairs (HIP) per minute exceeds the threshold of a safe workload for humans.

In order to assign baseline criteria for what constitutes a HIP, experienced air traffic controllers are interviewed using semi-structured interviews and informal conversation. Real open-loop air traffic data simulated through X-Plane is then analyzed to determine the number of HIP that occur per minute over a time period of 40 minutes. This data is then analyzed to determine if it is possible for human controllers to monitor/manage this task in a safe manner.

CHAPTER TWO: BACKGROUND AND LITERATURE REVIEW

Background

Next Generation Air Transportation System, or NextGen, aims to overall modernize the current air traffic control system across the United States. The overarching goal is to transform the system from ground-based, as it is today, to a satellite based system. The belief is that by moving to a satellite based system and utilizing global position systems (GPS) technology, air traffic control delays will decrease, planes will be able to fly closer together, overall airspace capacity will increase. As a result, controllers would be able to monitor and manage the air space with a higher degree of safety.

In order to increase capacity in the National Air Space (NAS) system, changes must be made to the way aircraft are managed and separated in their sectors. Currently, air traffic controllers manually monitor and manage each aircraft in his/her sector, keeping aircraft pairs separated from each other based on guidelines set forth by the Federal Aviation Administration, as well as personal judgment. Controllers communicate navigational commands to pilots directly via radio in order to maintain these separation minima, and are held accountable for any violations of separation. Each controller is able to handle between 12-18 aircraft in their sector at any given time without compromising safety of the overall system due to high workload (Erzberger, 2009) (Landry, 2012) (Wing et al., 2013). Because of this human factors constraint, it is necessary to manage air traffic separation in an environment with increased capacity using a different tool

Currently, the most developed concept for increasing the capacity of NextGen airspace is the automated airspace concept (AAC), which utilizes automated separation assurance (Erzberger, 2009). In this most developed model, there are three major components working together to help maintain proper aircraft separation so that collisions and near-mid-air-collisions (NMACs) are avoided to maintain system safety. These three proposed components are autoresolver, the tactical separation assisted flight environment (TSAFE), and an automated collision avoidance system (ACAS) (Erzberger, Lauderdale, & Chu, 2010) (Figure 1).

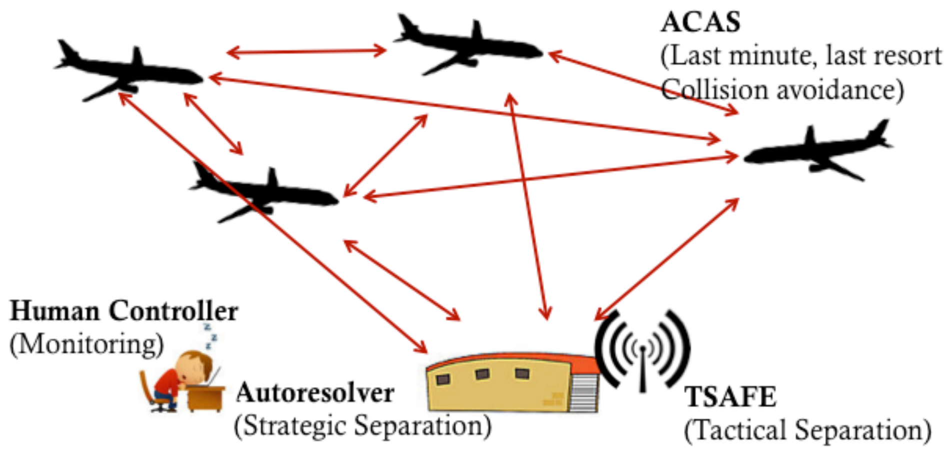


Figure 1: Illustration of ACAS

The autoresolver and TSAFE work together to predict and resolve future losses of separation between pairs of aircraft. ACAS detects rapid closure rates between aircraft pairs and aurally alerts pilots of the possibility of impending collision. ACAS also aurally provides resolution maneuvers to avoid the conflict (Landry, 2012). TSAFE and autoresolver evaluate the air traffic situations and potential conflicts in a primarily strategic timeframe (5 minutes to 2 hours ahead) while ACAS evaluates traffic situations on a tactical basis (0 – 5 minutes ahead). Ideally, these systems would all work together in symphony to predict and detect future loses of separation/collision hazards between aircraft pairs, as well as recommended solutions to resolve the conflicts.

However, these three systems have a series of flaws that can be categorized as either human-centric or design-centric. From a human-centric perspective, the first issue is that they all lack a way to keep the human controller "in-the-loop" in NextGen systems. Secondly, none of these systems are able to act preemptively and can only identify a problem and solution once a problem has already occurred (Landry, 2012). Both present major safety concerns, as a controller "out-of-the-loop" would have decreased situational awareness, as human monitoring of automation is notoriously poor (Parasuraman & Riley, 1997).

Furthermore, no work has been done to define or explain the failure rate of the automated separation assurance system. If the controllers were to act solely as monitors to the automation and the system were to fail suddenly at a traffic level higher than controllers are able to manually handle, it is unlikely that any controller would be able to obtain full understanding of the airspace and begin to act appropriately to avoid safety hazards in an acceptable amount of time. It is unreasonable to assume any human could monitor a system which they do not understand the reasoning or complexity of, and therefore, it is unreasonable to expect human controllers to monitor automated separation assurance functions. By nature, the automated airspace system is designed to handle tasks that humans cannot do on their own, so the system is far too complex for a monitoring task (Landry, 2014).

Additionally, human monitoring of automated systems and their ability to process pattern-formatted knowledge on the system without incremental failure of its parts (also known as graceful failure) is seriously compromised and becomes highly inadequate, so a sudden system failure would be a serious safety threat to the entire airspace system (Chen & Norcio, 1997).

Beyond the situation awareness deficiency, there are concerns about skill degradation, as controllers would go from active players in the process with 100% participation to simple screen monitors, and it is possible that their learned skills with the systems and the complex workings of their sectors would degrade over time. In the event of system failure, this kind of degradation, coupled with the stress of the situation, could lead to errors, which would seriously compromise the safety of the airspace system.

From the design-centric point of view, the system's design has an innate inability to preemptively detect unsafe situations could result in the possibility that a loss of separation could occur in such a way that the automated system could not detect and resolve the situation in a safe, timely manner. In such a situation, ACAS would be the only system available for conflict resolution, and this system has been proven unable to successfully resolve all conflicts, as it can give warnings to pilots with up to five seconds until a collision (Landry, 2012) . Actively identifying situations where, if an aircraft were to blunder, an LOS or collision would be quickly imminent could increase the safety level of the NAS, as well as addressing all of the noted safety concerns associated with ACAS.

Additionally, it is extremely important that the new system implemented with AAC be as safe or safer than the current system. The current system operates with a probability of mid-air collision on the order of $1\text{x}10^{-8}$ per flight hour (Belle, Shortle, Yousefi, & Xie, 2012) (Shortle & Zhang, 2014). This level of safety is generally established using quantitative methods such as reliability-based analysis (fault-trees, Markov chains, etc). However, these kinds of methods utilize an evaluation of each piece of the system, and are only effective if the probability of failure of each component is known (Landry, 2012).

A major flaw in AAC theory is that probabilistic conflict detection is not applicable, as it is near impossible to obtain a probability density function (PDF) that describes the likelihood of aircraft blunders, so the overall safety level of the system cannot be computed by automation alone. Blunder errors are erratic and not normally distributed by nature, and therefore cannot be modeled as a continuous distribution and cannot be found within any meaning confidence bounds. The large number of unknown variables that cause blunders makes a discrete distribution the only appropriate model, therefore rendering previously defined (Lauderdale & Erzberger, 2014) probabilistic conflict detection analysis impossible.

Intensity Control Measure

A potential solution that can solves the problems posed by the AAC theory is the introduction of the "intensity control measure" as a function for controllers to manually monitor (Landry, 2012). The "intensity control measure" consists of a calculation that can be run concurrently with other AAC algorithms which would compute the amount of time that an aircraft pair has before, if either were to blunder (perform an unplanned change of heading or altitude, Figure 2), the agents of the system (AAC, ATC, or pilot) would have less than 30 seconds to identify the problem, suggest a conflict-free solution, and execute the maneuver before a loss of separation (LOS) or collision would occur.

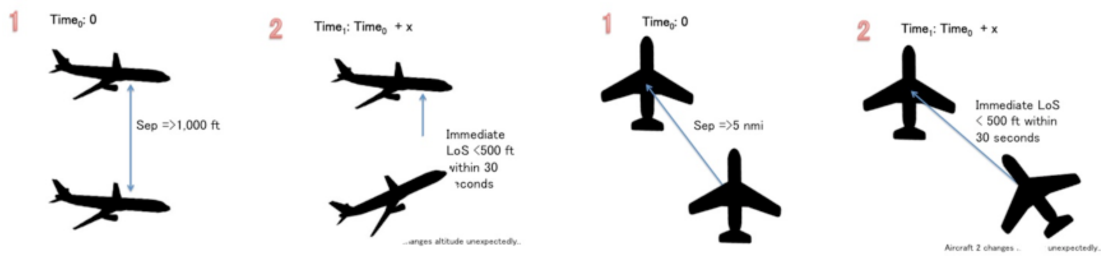


Figure 2: Blundering aircraft example

By allowing controllers to manually monitor this number for each aircraft pair in his sector, their experience and on-the-job knowledge could be utilized to intervene and increase separation for an aircraft pair they feel is approaching a critical time measure, all while allowing AAC to handle routine separation.

The introduction of this method would help keep controllers involved and aware of their sector activity as well as putting a measure in place to preemptively watch for and resolve dangerous situations that may result in a rapid LOS (Landry, 2012).

The intensity control measure can be computed using the following algorithm, which utilizes aircraft's' future position information given by systems such as Center-TRACON Automation. Given the future positions of an aircraft pair, the intensity number can be computed to show the minimum amount of time until a NMAC or collision would occur if either aircraft where to blunder in any possible direction.

Minimize $t = D^{-1}(500, \varphi, \dot{\psi})$

s.t. $t \geq \varphi / \dot{\varphi}$

$\varphi \cdot \dot{\varphi} > 0$

$\underline{\varphi} < \varphi < \overline{\varphi}$

$\underline{\dot{\varphi}} < \dot{\varphi} < \dot{\overline{\varphi}}$

where:

$D^2(t) =$ separation of the pair of aircraft $= (K_1^2 + K_3^2)t^2 + 2(K_1K_2 + K_3K_4)t + K_2^2 + K_4^2$

$K_1 = v_1 \cos(\theta_1 + \varphi) - v_2 \cos\theta_2$

$K_2 = \frac{v_1}{\dot{\varphi}}(\sin(\theta_1 + \varphi) - \sin\theta_1) - v_1\frac{\varphi}{\dot{\varphi}}\cos(\theta_1 + \varphi) + x_1(0) - x_2(0)$

$K_3 = v_1 \sin(\theta_1 + \varphi) - v_2 \sin\theta_2$

$K_4 = \frac{v_1}{\dot{\varphi}}(\cos\theta_1 - \cos(\theta_1 + \varphi)) - v_1\frac{\varphi}{\dot{\varphi}}\sin(\theta_1 + \varphi) + y_1(0) - y_2(0)$

v_i : *speed of aircraft i*

θ_i : *current heading of aircraft i*

φ : *blunder heading change*

$\dot{\varphi}$: *blunder heading change rate*

Ideally, each aircraft pair would have a minimum time to NMAC computed continuously, and within a sector, these intensity numbers would be available to help the system agents determine if the pairs require additional monitoring or spacing to avoid dangerous situations in the future. An example of an intensity computation where blunder errors of -90°, -45°, 0°, 45°, and 90° is shown in Figure 3. Intensity is computed in minutes.

AC Pair	-90 deg	-45 deg	0 deg	45 deg	90 deg
1,2	0.0137	0.5428	1.4525	2.4620	3.4301

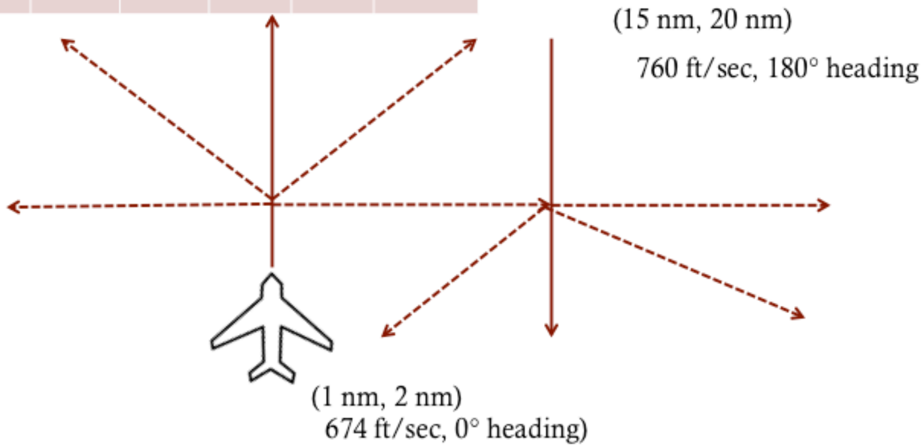


Figure 3: Intensity computation example

Since a combination of automated and human tasks is the most likely form of AAC that will be safe enough to implement, a list of these intensity numbers to manage could be a manual task for ATC perform while AAC handles routine separation. The notation of the intensity number is such that a small intensity number for an aircraft pair corresponds with a more critical situation. That is, an aircraft pair with an intensity number of 4.3 is more critical an aircraft pair with an intensity number of 5.8.

It is possible that an ideal intensity number exists; one where above it, spacing of aircraft pairs in the sector becomes so large that capacity is impacted, and where below it, safety is considered a risk for the pair. For the purposes of this research, a higher intensity number is always considered Pareto optimal.

The definition of intensity includes that the number defines a time until the aircraft could be 30 seconds or less away from a NMAC given a blunder, but it is important to note that the value of 30 seconds is a choice based on preliminary mathematical assessment, and is subject to potentially change. It has been shown that looking for these pre-emptive safety issues above 30 seconds could impact the ability to add capacity to a sector due to spacing (Landry, 2012). It is also worth noting that 30 seconds would encompass two radar sweeps, as each one last around 12 seconds, where in the first radar sweep, the problem would be identified, and during the second radar sweep, the solution would be executed, with around six seconds of additional padding.

A valid concern in the development and implementation of intensity as a function for controllers to monitor is if the levels of intensity would be too high for too many aircraft pairs in a high-traffic, increased capacity airspace, rendering controllers once again unable to safely manage their sector and handle the workload. Intuitively, as the number of aircraft in a sector grows, the buffer between aircraft will shrink (although not below the standard separation minima). Additionally, the time available until an aircraft pair reaches the critical moment where a blunder will cause of LOS or collision in 30 seconds or less without action will naturally become smaller and smaller as their buffer decreases.

Because the controllers would be required to visually scan for conditions, detect abnormalities, exercise judgment, and make decisions, monitoring intensity would be considered a task with high intrinsic demand (Embrey, Blackett, Marsden, & Peachey, 2006). Because of this, the hope is that situational awareness of a controller's sector is not lost while managing intensity, as opposed to just simply monitoring the automated separation assurance system for errors. Simply monitoring the automated system would involve tasks such as detection of audio alarms for error and performance of well-learned, highly routine activities, which are defined as tasks with low intrinsic demand, which result in lower engagement (Embrey et al., 2006).

The intensity control measure adds a level visibility and awareness for situations similar to the one illustrated in Figure 4 (Landry, 2012). Here, three aircraft are in close proximity to one another where aircraft 1, the central aircraft, is having its airspace breeched by aircraft 2. The AAC system would catch this violation of aircraft 1's airspace and most likely issue a directive to move aircraft 2 further away from aircraft 1. However, while aircraft 3 has not breeched aircraft 1's space, if it were to miss its planned right turn, there would be an immediate LOS and a very small amount of time until a NMAC would occur, or potentially a collision. This risk is not identified by AAC, but would be identified by the intensity control measure as a high-risk aircraft pair. The controller may choose to simply keep an eye on the pair, may ask either aircraft so slow down or speed up, or may ask aircraft 3 to confirm its upcoming maneuver to help ensure a blunder is not made.

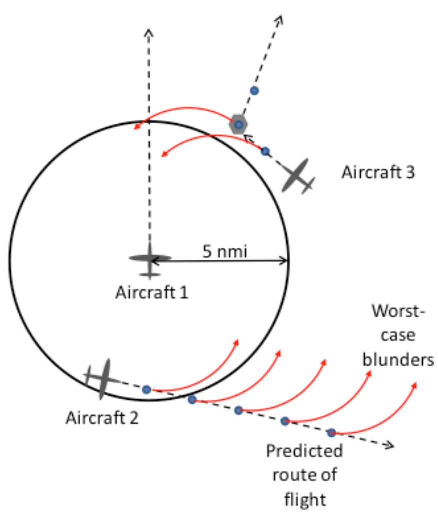


Figure 4: Intensity example (Landry, 2012)

Literature Review

In 2003, the United States Congress established the Joint Planning and Development office in order to oversee, plan, and execute the development of Next Generation Air Transportation Systems. The major components of this NAS overhaul are automatic dependent surveillance-broadcast (ADS-B), System-Wide Information Management (SWIM), NextGen Data Communications, NextGen Network Enabled Weather, and NAS Voice Switch. These elements are all elements of a plan to achieve several goals, which include trajectory based operations, collaborative air traffic management, a reduction in weather impacts, the ability to increase capacity at airports, and to rollout flexible terminals and airports. The rollout for the project is slated from 2012 through 2020, with a slow rollout of the various technologies and a mandate for compliance by 2020 (Administration, 2007).

A large portion of the ability to achieve the goals of trajectory based operations and collaborative traffic management, along with capacity increases, hinge on the ability of air traffic management evolving towards automation. Research regarding the evolution of NextGen all agrees that air traffic control will have to move to some level of automation, and most mention that the human controllers will need to have a role in the automated environment, but this task is not well discussed or well defined.

There is also healthy debate about the distribution of the separation responsibility. Some work spells out an argument for a distributed workload, where pilots/flight deck technology and the ground-based system would work together to manage separation, some are proponents of free flight where aircraft would always self separate, and others argue that the ground based system should maintain responsibility for all separation.

The idea of automating air traffic control has been a topic of discussion well before the NextGen initiative was announcing in 2003, however. Erzberger (1995) first began discussing the idea of Automated Air Traffic Management by presenting a rudimentary design principal and algorithm for a real time scheduler. At this time, the primary object was to find ideal or favorable landing scenarios for aircraft and schedule them in a sequence that minimizes delays throughout the airspace system. This early iteration of what would eventually mature into the Automated Airspace Concept focused not on increasing capacity, but merely increasing efficiency and minimizing operational costs for airports and airlines.

The proposed design and algorithm go so far as to assign ideal runways to aircraft approaching to land, although the simulation run only encompasses a single runway airport and acknowledges that a larger airport with more runways would be significantly more complex.

This research also proposes "meter gates" which are basically gates where aircraft would enter for sequencing and runway assignments in the TRACON. This work is also a precursor to future work being done in 4-D trajectory based operations, but it is the one of the earliest mentions of air traffic control done by automation (Erzberger, 1995).

The concept of automated conflict resolution is presented by Tomlin, Pappas, and Sastry (1998). Air transportation systems were seeing a drastic rise in demand at the time, and were expected to grow by 3-5% over the next fifteen years. The need for automation in air traffic control and aircraft separation is explained by inefficient airspace utilization, increased ATC workload, and obsolete technology. Tomlin et al. suggests that free flight would help to reduce some of the rigidity in the current system, allowing aircraft to fly in the most favorable winds and routes as determined by the pilot.

Furthermore, ATC are identified as frequently simplifying their heavy workload by putting aircraft in holds outside of the TRACON, which results in large delays in the system, and that the aging technology they use to manage aircraft is doing nothing to help them with their growing issues. Under this free flight system where separation is automated, each aircraft would have two "bubble" like areas that theoretically surround it; a tight "protected zone" which if breached, would result in a LOS, and an "alert zone" which would result in a kind of warning to the involved aircraft if it were breached.

Several innovative concepts are discussed here, such as a an algorithm to verify that a maneuver was executed in order to avoid a collision and the uncertainty in state or intent information, but this work does not address any function to keep human controlled in-the-loop, nor does this work address the inability to fully model the safety of the NAS using probabilistic conflict detection (Tomlin et al., 1998).

Erzberger first introduced the Automated Air Concept (AAC) in 2001. This work focused on eliminating the human controller as the means for aircraft maintaining separation and replacing them with ground-based computers that would "issue clearances to the pilot via data link to provide separation assurances for properly equipped aircraft." (Erzberger, 2001).

Erzberger (2001) suggests that the ground-based computers and pilots are equally responsible for aircraft separation, and that by relieving the human controller of his duties in manually separating aircraft, a larger number of aircraft can operate in Automated Airspace sectors. Erzberger admits the challenges of a large-scale component and equipment overhaul in order to implement the concept, and also that a safety net must be built for the event of failure.

The AAC system architecture proposed in this work is made up of several components; the aircraft, Data Link, the AAC computer system, TSAFE, and a controller interface. The proposed system would work in such a manner that the AAC system would issue a directive to the aircraft via Data Link, the aircraft would accept the maneuver and perform it in order to maintain separation. Safety concerns are addressed here by the addition of the TSAFE function, which is described here as a monitoring system that would help avoid LOS caused by critical component failures, software crashes, or errors by the pilot.

The controller would be expected to "accept separation responsibility" after any directives have been issued for maneuvers and that TSAFE has issued a clearance that the aircraft is not in any danger of a LOS. However, when another directive must be issued, the aircraft will transfer back to the automated system to be managed.

As described here, the controller would simply be a system monitor with no real task in the environment. This work goes on to discuss that human controllers would manage unequipped aircraft separation, but does not address how these aircraft would interact with equipped aircraft. Furthermore, this work does not describe a failure rate of the system, nor does it address the issues of poor human monitoring of automation and how to maintain safety in the event of a total system failure (Erzberger, 2001).

Just prior to the formal committee forming and announcement of the FAA's NextGen project, Erzberger and Paiell (2002) again addressed the need of a next generational air traffic control system to handle an increase in demand, the need for more capacity, and an improvement in efficiency and safety.

In this work, the role of TSAFE expands to independently monitor the clearances and trajectories sent via Data Link to the aircraft by the automated system, and would also monitor conformances. TSAFE would also issue warnings and advisories to pilots and controllers when needed. This research further states that with the separation task off the controllers' plate, they could focus on strategic traffic issues, such as flow management and pilot requests.

The more developed AAC system described here would enable controllers to re-route aircraft through the automated system by selecting conflict-free trajectories from the interface, coordinating the change with the pilot, and transmitting the new route via data link, but this would not be the controller's main task. Controllers would continue to manually separate unequipped aircraft, but beyond that, no task is defined to keep the controller active and engaged in the sector activity. This work does not address a decrease in controller situational awareness resulting from low task engagement, and this work does not address the failure rate of the automated system, or how a controller would regain control in the event of such a failure (Erzberger & Paielli, 2002).

In 2004, NASA formally published a report in which they outlined a proposal to "transform the NAS" (Erzberger, 2004) using AAC as the next generation of air traffic control. Here, it is stated that with this newly proposed system, pilots could request trajectory changes via data link, essentially downlinking their request to the ground based computer, where the computer would then check to make sure this request is conflict free, and then issue a clearance to the pilot to perform the maneuver or change of trajectory.

Again, the separation assurance system, known as TSAFE, is listed as the back-up function if the ground-based system were to fail. This research outlines the system in two time friends; strategic and tactical. In the strategic timeframe, which ranges up to twenty minutes, the automated trajectory server (ATS), which is the ground-based system, would initiation conflict resolutions with the time to LOS is greater than one minute. In the tactical timeframe, the LOS prediction range covers from 0-3 minutes, and resolutions are initiated when the time to LOS is less than one minute (Erzberger, 2004).

Essentially, in the tactical timeframe, if a LOS is detected, the TSAFE system would have to recognize the future LOS, initiate a resolution, send the trajectory change to the involved aircraft via data link, the pilot or pilots would have to receive the directive, and successfully complete the maneuver in less than one minute in order to avoid a LOS.

This work does not include any consideration or analysis of pilot workload under the introduction of these new tasks. It also does not discuss a task or function for human controllers to perform other than monitoring the automated system.

Erzberger (2004) does acknowledge that the ATS ground-based system could fail for a number of reasons, stating that the software would most likely contain "more than a million lines of code" (Erzberger, 2004), and the reliability and operational limits are most likely not feasible to establish it as a sole line of defense.

The redundant element suggested here is the TSAFE function. Erzberger does suggest that TSAFE would contain a critical maneuvers function, which would monitor the possibility of high risk LOS if an aircraft were to not terminate its current maneuver when the termination state is reached. That is, if an aircraft was cleared to climb from 10,000 feet to 12,000 feet, but continued to climb past 12,000 feet, the system would attempt to be forward looking to determine if there is any LOS risk. This is also known as the dead reckoning approach (Erzberger, 2004). This work does not account for the possibility of a blunder, nor does it describe the failure rate for the ground-based system, or how a human controlled could regain control of the airspace if needed.

This work also explains a safety analysis done on the AAC system, as described by Erzberger (2004). Four kinds of faults are identified which could result in a LOS; faults under normal conditions, faults due to incorrect information received by the aircraft, faults due to inability of aircraft to follow instructions, and faults due to ground system service interruption. Although the procedure or experiment for testing the level of safety for the AAC system is not described, Erzberger (2004) states that the level of safety achieved by the AAC system "appears to be increased significantly by features such as secure transmission of trajectories via data link, timely up linking of resolution trajectories when conflicts are detected, and extended conflict-free time horizons that allow traffic in the AAC controlled airspace to coast through ground system service interruptions with low collisions risk (Erzberger, 2004)." The rigor applied to proving or supporting these statements is not provided.

Alternatively, Metzger and Parasuraman (2005) suggest that it is unlikely that these automated systems would be able to cope with all situations, no matter how capable they are programmed to. It is noted that changes in pilot intent may not be received in a timely matter by the system, or may not be received at all for a variety of reasons, and it is therefore important to understand how controllers would perform with these kinds of decision-aiding automated systems, especially when they do not perform perfectly.

In Metzger and Parasuraman's (2005) study of how controllers performed in a free flight situation, they found that in high traffic situation (that is, one that is higher than current levels of traffic) where the automation was working perfectly, in a simple monitoring task, controllers were only able to identify 62.5% of conflicts without help from the system, alerting them to these situations. With the help of an automated decision making aid, controllers were able to identify 70.83% of conflicts, a marked improvement. This experiment also suggests that if the automated system were to suddenly fail and controllers had to immediately take manual control of their sector, a high percentage (around 30%) of potential LOS would go undetected.

They went further to test such an environment where the automation was not working perfectly, and the results proved to be the opposite. With no decision-making aid from the automation available, controllers were more likely to identify a conflict when working manually than when assisted by automation that was failing (Metzger & Parasuraman, 2005).

This work does not address pilot workload, nor does it address situational awareness of the controllers in an automated environment. This experiment shows a valid point, that the automation, when imperfect, is a poor substitute for a human controller, but the task of controllers simply calling out and identifying LOS between aircraft while the automation handles it does not seem realistic in a live environment.

Erzberger again addresses the concept of automating the separation assurance for air traffic control, and begins to include ADS-B technology as part of the plan, as well as an updated procedure list for the TSAFE function (Erzberger, 2009).

TSAFE, as described in this work, remains a back-up function to the ground-based system, which would also incorporate information from Mode S transponders from appropriately equipped aircraft. Mode S transponders are currently standardized by ICAO already, and provide such functions as automatic reporting of aircraft identity, altitude reporting at 25-foot intervals, flight status (airborne or on the ground), and data link capabilities. These capabilities would help TSAFE receive information and send information such as flight directives. The major difference presented here is the new timing procedure regarding TSAFE and LOS warnings.

In this new work, the controller is presented with a warning from TSAFE when an aircraft or pair of aircraft was two minutes away from a LOS. One minute later, if no action is taken and the conflict remains unresolved, TSAFE will uplink a conflict resolution directly to the aircraft, and then the aircraft would take immediate action to avoid the LOS. TSAFE would maintain control of the aircraft until 60 seconds after the LOS is avoided or occurs, and then control would be handed back over to the human controller (Erzberger, 2009).

Erzberger's work in 2009 goes on to describe a set of "evolutionary steps" towards automated separation assurance (Erzberger, 2009). Here, four levels of automation in separation assurance involvement are addressed, moving from automatic long range en route conflicts in stage one to automatic sequencing of arrivals in stage two, to automatic handling of short range conflicts in stage 3, and finally to the integration of short and long range automated separation assurance in the final stage four. The human controller would slowly lose responsibility for separation, and by stage four, the controller would only handle specific situations (Erzberger, 2009).

This work does not address a function or task for human controllers to perform which would continue to keep them engaged and in-the-loop. It is of concern because, given system failure or imminent LOS, the controller's ability to safely assess the situation, understand the aircraft movement, gain control, and provide solutions to avoid

LOS in a timely manner would be seriously compromised with a low level of situational awareness.

One limitation of the system that was addressed early on was the ability for the algorithms to safely provide aircraft with alternative routes for weather avoidance. Dangerous weather pops up quickly, and can render a large area of a sector impassable, so it is important that the system be able to handle these kinds of deviations in a quick, safe manner.

Erzberger, Lauderdale, and Chu (2010) discuss a unified solution for difference kinds of separation assurance problems which occur en-route, including weather, normal separation assurance, and arrival sequencing, stating that it is important for all algorithms in the ground-based system to work together, especially in the case of these issues occurring simultaneously. Three different, yet integrated, algorithms are proposed. The proposed version of Autoresolver takes TMA (Traffic Management Advisory) schedules and weather cells into account, as well as if the aircraft in an aircraft pair is sequencing for arrival or not, and then combines three algorithms to propose one solution to solve any combination of issues that arise from the input information (Erzberger et al., 2010).

These three algorithms; the arrival manager algorithm, the weather avoidance algorithm, and resolution generator algorithm, combine with TSAFE, which in this research, now manages a 0-3 minute window until LOS (as opposed to the previous suggestion of 0-2 minutes), to provide all equipped aircraft in a sector with conflict free trajectories, communicated to the aircraft via Data Comm (or data link).

It is still suggested that the human air traffic controller manage any aircraft that is not equipped with Data Comm and other automatic separation technologies (Erzberger et al., 2010). While this system would undoubtedly carry more capacity for the NAS, and may have a higher efficiency level than the current system, the failure rate of the system is still undefined, and a comprehensive task which keeps controllers actively in the loop, as opposed to just monitoring automation or manually managing a very small number of unequipped aircraft, also remains undefined.

These algorithms also do explain their comprehensiveness, or how they can account for undefined errors, such as blunders, which have no known probability density function by which to statistically predict them.

Belle, Shortle, and Yousefi (2012) add that it is important to have the ability to measure conflict risk in this new automated system. Here, they use a NAS wide simulation to make estimates of conflict rates under the assumption of no conflict resolutions. That is, they are trying to find the rate at which conflicts occur in high traffic load sectors when aircraft are on their planned trajectories with no changes.

The results of the simulation found that, with roughly 35 aircraft/sector/15 minutes, about 3 LOS occur, and about 0.06 NMAC/sector/15 minutes occur. These rates were found in airway routes, which tend to be larger, structured sections of airspace. The simulation was also run on super high airspace sectors to find the conflict rate per flight, and the rate of LOS/flight/sector/15 minutes was found to be 0.08 (Belle et al., 2012). Algorithms are given which fit the data points, and could be used to estimate the rate of LOS, NMAC, etc in the future.

It is of note that this research is done to simulate a 1.5x traffic sector, where the flight count is per 15 minutes, not per minute. That is, 35 aircraft pass through the sector per 15 minutes, not all at once.

Lauderdale and Erzberger bring up the concern of maintaining separation assurance in a highly dynamic environment, such as a sector with active weather (Lauderdale & Erzberger, 2014). Here, a new algorithm is added to previous work done by Erzberger (2004) which used geometric calculations to determine routes for aircraft to fly tangentially around weather cells in a conflict-free way. This builds upon Erzberger, Lauderdale, and Chu's (Erzberger et al., 2010) earlier work, and adds a higher functionality to the tool, allowing for the development of conflict-free routes around multiple, complex cells of weather (Lauderdale & Erzberger, 2014).

Increasing the robustness of trajectory uncertainty is also discussed, where top-of-descent vertical buffers and probabilistic conflict detection are introduced. A top-of-descent vertical buffer is an additional bubble of space around an aircraft that is descending near the vertices of the expected turn, providing a measure of safety incase the aircraft where to decide to start descending earlier than planned. This would aim to clear out the airspace immediately below and in-front of the predicted descent point (Erzberger, 2004).

Probabilistic conflict detection would use knowledge of the past performance to predict if two aircraft on certain trajectories have the possibility of colliding trajectories (Lauderdale & Erzberger, 2014). This method of increasing certainty in conflict detection, however, does not include blunders, as the PDF of blunders, by nature, cannot be defined with a safe level of certainty.

Overall, most of the research coming from Erzberger, his team, and his associates in NASA and academia is centered around a totally automated system, where the automation handles most, if not all, separation and traffic management responsibilities, and the human controller plays a very limited active role and tends to act more as a monitor. Very little work has been done to address the human factors and safety concerns presented by this, nor has much discussion occurred to identify a task for controllers. However, some outside of this team have been working towards a human-centric solution.

Landry and Lynam (2011) discuss the ability of pair of aircraft to perform closely spaced parallel approaches, where an algorithm to find the “safe zone” around the aircraft in respect to wake vortexes is introduced. The algorithm is a combination simple kinematics that calculates the minimum amount of time until a lateral separation between a pair of aircraft reaches 500 feet. These particular equations do not take blunders into heavy consideration, but they do account for a blunder where an aircraft makes an offset turn and then remains on that reckoning. That is, the equation does account for a blunder that occurs and is not corrected. These calculations also do not account for changes in aircraft speed (Landry & Lynam, 2011). The idea of the safe zone is similar in concept to the top of descent vertical buffer mentioned earlier (Lauderdale & Erzberger, 2014), but Landry and Lynam begin to account for blunders not just in altitude or heading changes, but at all times during the aircraft pair approach.

Given that these calculations do account for an uncorrected blunder, it is possible to define a safe zone around each aircraft, saying that within the next 30 seconds, 45 seconds, or 60 seconds, this pair of aircraft will not be subject to a LOS, even if they were to blunder with a range of 30 degrees, which is considered a worst-case scenario blunder (Landry & Lynam, 2011). This work is not in the regards to automated separation, but these kinematic equations play a large role in the development of the intensity control measure function, which is the topic of this dissertation.

Building on the idea of a safe zone and attempting to fill the gap of knowledge as to what function controllers would perform in wake of automated separation, the idea of the intensity control measure is introduced as a solution for human controllers (Landry, 2012).

Here, intensity is defined as the amount of time until, if either aircraft in a pair were to blunder, any agent of the system would have 30 seconds or less to detect and resolve a LOS (Landry, 2012). Operationally, this would defer a critical-safety task to the human controllers, where they would see a list of "high intensity" aircraft pairs that they could choose to either continue to monitor, resolve manually, or ask the automated system to suggest a resolution (Landry, 2012). This is the first mention of an actual task for human controllers to perform that would be potentially engaging enough to keep them in the loop and capable of safely regaining control of a gracefully failed automated system.

Furthermore, other trains of thought exist where ground-based automation is not the only system working to manage air traffic control. Several different theories have been presented that either choose to test the idea of automation as a tool for human controllers to leverage, or test the idea of having separation be a shared function between automation on the ground and systems in the cockpit with the pilot.

Morey and Prevot (2013) recognized that having humans interact with automation, such as in the proposed automated separation assurance system, would be tricky, as the system will naturally be imperfect, and it is likely that the users will all use and interact with it differently. Essentially, system performance by itself does not guarantee success in a human-system interaction, as operational situations change, operators and their preferences differ, and there tend to always be cases where the automation is totally set aside in favor of manual control, such as Autopilot. Therefore, it is concluded that the some changes must be considered for a success automated separation assurance system (Morey & Prevôt, 2013).

In this work, two experiments were done where two different controllers were in control of the same sector with the same traffic, and had the same goals (maintaining separation in en route sectors and delivering aircraft to the meter fix), although they worked separately in different rooms. Two kinds of error were introduced into the aircraft and their trajectories; wind and actual aircraft performance error. The controllers in the experiment had a series of tools at their disposal, a mixture of those currently in use and some prototypes. Of note, they were given access to a tool which allowed the controller to query the automated system for a resolution for a delay or advance as well as a tool which allowed them to test a conflict or metering resolution and see the expected result before a clearance is issued.

Throughout the experiment, the controllers unanimously agreed that the trial tool function which helped provided a conflict free speed for aircraft to get the delay as close to zero as possible was the most useful and most stable. Neither felt the route-trial planning tool was particularly useful, although there was some interest in the altitude-planning tool, which shows conflicts and delay times that would occur based on an entered altitude change for an aircraft (Morey & Prevôt, 2013).

Overall, the controllers all reported that they used the information provided by the tools indirectly, meaning that they took the information provided by the automation into account, but ultimately made air traffic control decisions on their own. Controllers also tended to use the tools less as errors occurred more often.

Overall, all controllers had effective strategies for managing the traffic in each sector, however, they differed immensely and both used the tools in completely different ways. Even in the face of large errors coming from the trial tools, controllers were able to safely manage the aircraft, and seemed to be able to adapt the information or use it peripherally instead of directly (Morey & Prevôt, 2013).

This experiment does not account for any increased levels of traffic, but does make an interesting and valid argument for the integration of human control tasks within automation. The automation tended to present more errors to the controllers in the face of wind uncertainty and aircraft error or nonconformance, and would present clear danger to the NAS if it were the only tool being used to maintain separation. Morey and Prevot (2013) also mention that there are some skills and a level of adaptability that is inherent to a human controller which cannot be transferred over to an automated system, therefore making the human portion of the ATC control loop a vital one.

In 2013, the FAA, in conjunction with several technology companies, released the results of their own controller-in-the-loop experiment (Harrison, 2013). This experiment was designed to test the impact of Conflict Resolution Advisories (CRA) on the capacity, safety, and efficient of air traffic control operations. This experiment tested the use of this tool, which is essentially an automated tool that provides controllers with possible solutions for conflict resolution, on both the R-side and the D-side (Harrison, 2013). The R-side can be defined as the "radar man" and is considered a complimentary role to the controller who is manually separation aircraft without using radar, sequencing strips, etc. The D-side is the controller who is manually separating aircraft, sequencing strips, and assisting the R-side with hand-offs and coordination other adjacent sectors. Although this study took place in 2013, the R-side and D-side controllers roles are often mixed together and often times one controller performs both roles (Snoddy, 2014).

Overall, the controllers in the experiment, who controlled an en-route sector, found the CRA tool to be useful, but many commented that it wasn't useful or they tended not to pay attention to the tool when their sector became particularly busy.

Furthermore, the level of workload did not decrease significantly when controllers were using the CRA tool versus when they were performing their baseline functions with no support from the tool. There was a slight decrease as the experimental runs continued, and this may be attributed to controllers understanding the CRA tool better and perhaps trusting it more often, but the decrease in workload was not significant. Also, most controllers in the experiment thought the CRA tool presented too much information at once, and most of it was not useful (Harrison, 2013).

The CRA tool presented the controllers with the wrong altitudes for direction of flight several times, and this was when controllers reported they found it the most useless. When this happened, all controllers in the experiment completely disregarded the CRA tool and reverted back to baseline, manual tactics to manage the separation. Overall, the number of tactical conflict alerts, that is, conflict alerts with less than 2 minutes to resolve them, decreased when controllers were using the CRA tool (Harrison, 2013).

After the experiment was complete, the controllers were asked a series of questions to rate the impact of the automation on the ability to perform their job. On a scale of -5 to 5, -5 meaning the tool had a very negative impact and 5 meaning the tool had a very positive impact, controllers responded that with regards to finding a solution to a conflict, the automation had an impact level of around 1.22, meaning it had a very minor positive impact. Overall, in the response to these questions, controllers generally rated the automation as having a very minor positive impact to their jobs in all aspects, with the highest response be 2.61 for the effects of Data Comm (data link) on workload, meaning it had a fairly positive effect on reducing workload for them (Harrison, 2013).

When asked about the number of false alerts and nuisance conflict alerts that the automation presented, all controllers found these levels to be unacceptable, and they all found the automation to be mildly distracting while working.

However, they also all reported that they found using the CRA tool somewhat improved the accuracy of their work and found the accuracy of the tool itself to be somewhat acceptable, rating the accuracy of the too at around 1, where 5 is acceptable and -5 is unacceptable.

Overall, the total effect of the CRA was rated as 1.08 by the controllers, on a scale of -5 to 5, where -5 is the CRA hindered their jobs greatly, and 5 means the CRA helped their job greatly (Harrison, 2013).

The overall takeaways and recommendations from the experiment stated that the version of CRA tested involved too many clicks for controllers, too many false alerts, too many solutions for problems, and presented solutions too far in advance to be useful. Controllers also found the display to be distracting, found themselves not scanning their sector as rigorously because they were relying on the CRA, and found that sometimes, no option was presented for a resolution when it should have been.

Controllers widely reported that it was simply too many steps to use the CRA tool when they were very busy and often did not use it during such cases. They also found that altitude resolutions to be out of conformance (odd altitudes for aircraft traveling east and even altitudes for aircraft traveling west were not a constraint for the CRA tool). Also, some solutions presented with very large heading change angles that are unrealistic to execute in real life.

With regards to coordinating between sectors, controllers found that it did not present alerts in a timely manner, and that when they were very busy, it was easier to call planes on the radio than to go through the process of using the CRA tool (Harrison, 2013).

Harrison (2013) and Morey and Prevot (2013) are presenting an interesting side in the automated separation assurance argument, where automation is simply used as an aid rather than a total takeover. In both experiments, the traffic levels testing only range from less than current to just over current (30%-130%), so these solutions may not be applicable for traffic levels higher than 1.5x, but both make an interesting point that these automated systems have errors and gaps in logic that must be made up for by the human controller to be successful.

A previous study done by Prevot, Homola, Mercer, Mainini, and Cabrall (2009) also concluded that while total automation may be needed at some point in the next 20-25 years, using automation as an aid for conflict resolution to human controllers is a viable option in the near future. They identified shortcomings with short term conflict resolutions, citing that work needs to be done to allow for a delay in execution of short-term conflict resolution maneuvers, as flight crew could take up to 30 seconds to receive the direction and execute it. It is also noted that occasionally these automated aid tools suggest maneuvers that are not realistic (Prevot et al., 2009).

Near-term conflicts are also of interest in this study. Prevot et al. notes that controllers were almost always able to resolve conflicts with almost no notice, and this points to the human's ability to improvise and make fast, sound decisions in a precarious situation, but that this human ability should not be totally relied upon.

It is also noted that it takes human controllers more time to help aircraft regain their trajectory-based operations once they've been maneuvered off-course to avoid a LOS. Improving the reaction time of the automated system, and strengthening its ability to resolve a conflict by moving the aircraft pair to a safe heading or altitude, and then moving them back to trajectory based operations in a safe amount of time, is critical to making the automated tool more useful or even indispensible in a higher traffic environment (Prevot et al., 2009).

Another heavily discussed theory for air traffic control management to handle increasing traffic is to have function allocation between the ground-based system and systems inside the cockpit. Essentially, appropriately equipped aircraft would self-separated, and then any non-equipped aircraft would be controlled by the ground-based system. Wing et al. (2013) discusses the possibility of this kind of function allocation and runs a series of experiments; one to focus on the controller and his roles, and another to focus on the pilot and his roles, and his ability to maintain separation and fly the aircraft safely.

The first experiment Wing et al. conducted was to examine the impact of self-separating aircraft on ground-based separation assurance management in different level of traffic increase. The experiment asked two questions: (1) would self-separating aircraft impact the controller or ground-based automation's ability to separate aircraft, and (2) would operations work different under different levels of traffic increase (Wing et al., 2013). Two different conditions were tested, one contained only Instrument Flight Rated (IFR) operations, and one contained a mixture of IFR and AFR (automated flight rules), where AFR refers to aircraft that self-separate. Another variable of the experiment was the level of NextGen being implement. That is, in the baseline scenario, the equipment level and communication abilities mimicked those of the current system.

In the Minimum NextGen scenario, 25% of simulated aircraft had limited data link with the ground system, and a 20% traffic increase was implemented. In the Moderate NextGen stage, 50% of aircraft were data link equipped, traffic volume was increased by 50% from baseline, and AFR aircraft had trajectory intent of surrounding aircraft (i.e. they were equipped with ADS-B in and out). In the Maximum NextGen scenario, all aircraft were equipped with data link, and automation handled all aspect of separation. This scenario included that maximum level of traffic per sector that is expected in next NextGen, which is 35 aircraft per sector (Wing et al., 2013). This resulted in 8 experimental conditions.

Controllers were asked to manage the airspace according to the level of automation available in each experimental run, and the results were interesting. In an IFR-only scenario, at baseline conditions, only 1 LOS occurred. At minimum NextGen, 3 LOS occurred, at moderate NextGen, 10 LOS occurred, and at maximum NextGen, 0 LOS occurred. In the mixed IFR/AFR environment, at baseline, 1 LOS occurred, at minimum NextGen, 3 LOS occurred, at moderate NextGen, 5 LOS occurred, and at maximum NextGen, 2 LOS occurred. Approximately half of the LOS events were traced back to automation failures that resulted in late conflict detections, and the other half were related to operator/automation failures (Wing et al., 2013).

Controllers felt that their workload was moderate. When asked to rate their workload on a scale of 1 to 6, 6 being very high, in the first three scenarios, the mean workload was just over 3, and for the maximum NextGen scenario, the mean workload was around 1.8.

Controllers also found the scenarios generally acceptable, as far as level of risk, although in the moderate NextGen scenario, they felt their desired performance was not reached and required controller compensation. This lower rating for the moderate NextGen scenario came primarily from two controller subjects who felt that scenario was unsafe, reporting that they felt they were put in a position multiple times where they could not control the traffic in a safe amount of time (Wing et al., 2013).

The second experiment was pilot focused, attempting to address the perspective of the AFR pilot in mixed operations. The main focus of the experiment was to identify limits under which AFR aircraft can ensure separation from other aircraft, particularly unequipped IFR aircraft. Several variables were tested, such as time to buffer loss (TBL), encounter angle, maneuver angle, and passage orientation.

When the initial alert time to an impending LOS was presented to the pilot between 1-10 minutes in the experiment, there was no LOS. When the alert time came between 20-60 seconds, 11 LOS occurred, and when it came less than 20 seconds before, there were zero LOS. With regards to the buffer loss, when the alert time was presented at 4-10 minutes, there were zero buffer losses. At 2-4 minutes, there were 3 buffer losses, at 1-2 minutes, there were 13 buffer losses, at 20-60 seconds, there were 37 buffer losses, and at less than 20 seconds, there were 10 buffer losses. The most dangerous time frame for pilots to receive the alert of impending LOS or buffer loss was between 20-60 seconds.

It is hypothesized that this amount of time is deceiving, as it seems there might be enough time to plan and execute a maneuver. However, often times, this was not the case. In the less than 20 seconds range, pilots seemed aware that they had to take immediate action and tended to make decisions with instinct and experience rather than using the automation to find a conflict free route, which may have contributed to the lower about of LOS and buffer losses in the less than 20 seconds range (Wing et al., 2013).

Overall, the impact on controller workload and ground-based operations wasn't significant in the first experiment when using IFR/AFR mixed operations, but the high level of LOS and buffer losses for pilots being alerted to them within 20-60 seconds is a cause for further investigation. This shows a significant gap in the workload ability for pilots to identify a LOS or buffer loss problem, find a solution, and execute the maneuver in this time frame. This gap is a security concern for the ability of mixed operations function allocation. Other than briefly touching on a workload measure, this work does not take human factors into account, such as a task to keep controllers engaged.

This work was further examine in a subjective manner by Burke et al (2013), where pilots of a similar experiment to Wing et al. (2013) were asked to rate how their perceived their mental demand, physical demand, temporal demand, effort, frustration, and performance on a scale of 1 – 11, where 11 is the best possible outcome, in a self-separating AFR scenario.

Mental demand was rated at a mean of 5.20, physical demand had a mean of 3.75, temporal demand had a mean of 4.86, effort had a mean of 4.25, frustration had a demand of 3.33, and performance had a mean of 9.86. Overall, the pilots were satisfied with their performance. However, it should be noted that this was a simulation environment on a desktop computer and pilots were using a mouse to control the simulator. It is noted that results could drastically change if pilots were flying in a full-scale, fully-equipped simulator or flying real aircraft (Burke et al., 2013).

One major concern of automation in air traffic control is the ability to ensure pilot/aircraft conformance to directives given by the system, as well as the accuracy and ability of the system to perform at a high enough level to ensure a level of safety that meets or exceeds the current level of $1x10^{-8}$ accidents/flight hour. Santiago (2013) discussed the need for a supplementary tool to the AAC system which checks for aircraft that are out-of-conformance, and then provides a safe solution for them to rejoin its assigned route or altitude.

Santiago (2013) defines non-conformance in the vertical domain as an aircraft being at a flight level of more or less than 300 ft. than its assigned altitude, climbing when the assigned altitude is not above the current one, or descending when the assigned altitude is not lower than the current one. Lateral non-conformance is defined as an aircraft who is off its assigned route by more than 7.0 nautical miles, and/or whose angle to fix is greater than 30 degrees.

Flights that are out of conformance pose a serious risk to the automated resolution algorithms, as they mostly rely on trajectory based intent. Therefore, if a flight is veering too far off course, the solutions for conflict resolution will be wrong and non-applicable to non-conforming flights (Santiago, 2013).

In order to help bring non-conforming flights back into conformance, Santiago suggests an automated function called "recapture," which is a series of algorithms designed to find a conflict-free route for a non-conforming aircraft to rejoin its original assigned route. These algorithms are meant to consider the challenges in doing so by focusing on a list of candidate fixes for aircraft to hit on a path to rejoin its original route, and the destination fix will never be a candidate fix. This is done to avoid unrealistic maneuvers as well as take other traffic into account to avoid conflicts.

Santiago performed an experiment where when lateral non-conformance cases were detected, the algorithms were able to successfully reroute the aircraft back to its original flight path 96% of the time. It is also noted that the current version of Autoresolver that has been tested cannot perform accurately when aircraft are flying open-ended vectors or temporary altitudes, and this discovery is crucial because without this capability, it cannot successfully interact with TSAFE. Without this addition to autoresolver, it would be difficult for conflict free recaptures to be successfully planned and executed (Santiago, 2013).

Aside of human-factors driven safety questions, reliability is clearly one of the most important components of making the automated system viable for use in any capacity in air traffic control and management. Li and Zhou (2013) propose a safety evaluation index utilizing failure records as well as an analytical hierarchy process to evaluate how reliable the automated systems are. Here, the system is evaluated on four different levels; humans, management, equipment, and environmental factors. Each factor is subsequently evaluated by a set of more nuanced factors to give it an overall "score." For example, in the "humans" group, the score is affected by technique and manner (which includes professional dedication, professional skill, on the job training, safety awareness, and observing discipline), physiological status (which includes fatigue and boredom, physical condition, and drug abuse and intemperance), and psychological factors (which include work psychology and mental quality).

Li and Zhou propose that these factors, along with the other 3 factors and their breakdown of more nuanced factors, be used to evaluate reliability of automated systems for use in air traffic control. Future work includes the development of a software analysis tool for operational condition evaluation of the automated system (Li & Zhou, 2013).

Furthermore, safety and security of the automated system is another concern. In the current environment of fast technology and extreme availability of computing knowledge and power, secure systems are becoming more vulnerable to malware attacks or malicious data insertions to disrupt the state of the system.

Park et al. (2014) acknowledges that security is a major consideration in making NextGen upgrades to the air traffic control system, particularly those that would be reliant on GPS tracking, data uplinking technologies such as data link, and also any of the automated technologies which essentially receive input from the GPS system and the flight management systems and run it through millions of lines of code to determine routing.

Some of the major challenges outlined include an adversary inputting a high volume of false messages into the data link system, an adversary overriding positioning data which would confuse pilots and the AAC system, and also the possibility of jamming GPS signals which could make triangulation very difficult (Park et al., 2014).

Some solutions have been proposed to solve these issues, such as centralized localization and distributed localization. These solutions come with many drawbacks, mainly the high cost associated with communication and specialized hardware.

One solution presented by Park et al. (2014) is the Misbehavior Detection System (MDS), whose role is to detect off-nominal aircraft. Off-nominal aircraft are defined as any kind of malicious behavior being executed in the airspace system with the intent of exploiting the weaknesses of the satellite-based navigation system. The MDS would protect the interface between aircraft networks, onboard systems, and data services. It would monitor the status on these systems, and provide real-time detection of abnormalities or suspected malicious attacks.

One possible option available for integration utilizes a GPS/INS integrated system with a Kalman filter. The Kalman filter helps to fuse high frequency sensor information with low frequency GPS data and estimates the errors in position and speed using the difference between the two data readings.

Another option would use a Doppler/RSS fusion process with a Kalman filter. To find the current position of an aircraft, given an adequate number of neighbors, ADS-B positions are received via the Doppler effect and RSS measurements, and the distance is calculated using the minimum mean square estimate. Using this, a modified Kalman filter can help find the actual position using system state dynamics.

Ideally, both methods would run concurrently and would be evaluated side-by-side. If there were discrepancies between the two methods, this would identify to the system that there was an error, and a potential adversarial situation, and it would be flagged for review. The advantage of this method over previously proposed solutions is that it simply uses enhanced functions of systems and technologies that already exist; so minimal infrastructure investment would be needed (Park et al., 2014).

Park et al.'s solution also takes separation assurance into account. Uncertainty of surveillance information is accounted for by using a control algorithm that minimizes flight time while evaluating positions for anomalies or off-nominal aircraft. The primary variable used here is changes in velocity, and minimum separation is taken into account via a series of separation minima.

However, this separation algorithm also takes a predefined minimum probability for adversarial events into account. Under this control algorithm, aircraft would either be paired or unpaired. Paired aircraft would be leading to the same fix, while unpaired aircraft would be leading to different fixes. These geometric constraints are part of the control algorithm that would go into minimizing trajectory changes, reducing overall flight time, and adding a small buffer in for adversarial events while maintaining separation minima (Park et al., 2014).

Many challenges are recognized for implementation of these methods. The first being that non-cooperative aircraft exist in the airspace, and this will cause delays throughout the system that could override the benefits. Also, if two aircraft are projected to reach a fix or merge point at exactly the same time, delays will naturally be incurred due to a series decision-making processes, such as determining which aircraft in the pair will receive preference (Park et al., 2014).

A series of simulations are run to test the concept of MDS, along with the control algorithm. In the first basic run, the algorithm was able to successful detect malicious aircraft actions, and was also able to detect a sophisticated GPS attack. The tested algorithm was discrete, requiring updates to system operations at discrete time events, but future work outlines the development of the algorithm into a continuous state. It is also noted that a serious limitation for consideration is the possibility that implementation of this system could cause efficiency reduction in the airspace due to the additional buffers put in place for malicious aircraft events (Park et al., 2014).

CHAPTER THREE: METHODOLOGY

Definitions for Analysis Thresholds

In order to analyze if the number of aircraft pairs with a critical intensity number in a sector is acceptable and safe for human controllers to manage, several threshold values must be informally defined.

The threshold values are defined by a series of short, informal, semi-structured interviews with one retired air traffic controller with 25 years of experience, and a series of short, informal interviews with one active air traffic controller with 24 years of experience.

The retired controller, now an FAA representative, was interviewed twice for one hour each, along with a series of electronic correspondence. The first one-hour, in person interview was an explanation of the intensity control measure concept, where the retired controller was given several pieces of literature to explain the concept, as well as a verbal conversation. The controller was given a questionnaire to fill out, regarding his opinions on what a he felt appropriate threshold values would be. The second one-hour meeting was one week later to discuss the questionnaire responses and try to understand the controller's reasoning and theories for his answers.

The currently active controller was also met for two live interviews in the same format. A third additional meeting took place at the SOCAL TRACON center, his place of employment. This meeting served as a follow up to demonstrate some principals and practices that he had explained in the interviews, as well as for data to be collected in a very simple, preliminary manner to help establish analysis parameters.

Follow-up communications with both controllers were established via e-mail in order to confirm the conclusions draw from interviews. These communications also served to communicate for the thresholds and parameters chosen for analysis. Additionally, these communications helped to confirm controllers felt the chosen thresholds were representative of their information and their consultation.

The first important threshold to consider is what is defined as a critical intensity number. Both controllers felt that, given initial information and based on the understanding of the problem, any aircraft pair with an intensity number of 6 or below should be considered critical. Snoddy (2014) concluded that the "idea of intensity already works in the minds of most controllers and we usually manage for it anyways, even without a real calculation. My initial reaction is to tell you that if I saw a set of planes with this intensity number of five, I would start watching them much more seriously, so to add a buffer to that, I would say 6 or 6.5 minutes should be your cut-off."

Spillane (2014) also commented that while he has never seen an actual intensity calculation in air traffic control previously, he "understands the concept fully," and feels that "this kind of measurement is already taken by most controllers simply in their heads, based on previous behaviors and conditions. For a cut-off, 10 minutes seems too far in advance, but five minutes seems to close, because five minutes goes by very quickly when flying and controlling traffic. Six to seven minutes seems like a nice place to start."

For the purposes of this research, an intensity control number of 6.0 or below will be considered a high intensity aircraft pair (HIP). Both controllers agreed that 6.0 as a threshold is a valid and reasonable threshold to use for this analysis. Additionally, the data will be analyzed with HIP definition at 1.0 and 2.5 to increase the understanding of the intensity measure. HIP defined as 1.0 or below is chosen because both Snoddy and Spillane commented that 1.0 instinctively feels like the lowest possible HIP definition possible to use without compromising safety, and a HIP definition of 2.5 or below is chosen because it was identified by Snoddy as another possible option (Snoddy, 2014; Spillane, 2014).

Next, it is important to determine what percentage of these critical aircraft pairs would likely require the controller to apply some kind of action or intervention, a safe intervention percentage. That is, what percentage of these highly intense aircraft pairs would add to the controller's workload.

Snoddy (2014) commented that unless a direct conflict alert is given, he feels that he intervenes to help avoid the chance of a conflict for 5 out of 10 aircraft. However, he also feels that, without managing normal separation, as in an automated environment, the algorithms and system would be doing so, he feels more attention would go towards avoiding possible future problems brought on by blunders. In this case, he feels it would be more likely that controllers would intervene for up to 7 out of 10 aircraft in their sector at a given point in time.

Spillane mentioned that this measure "is subjective and depends heavily on the controller, the airspace, the terrain, and the weather." He goes on to explain that "most controllers tend to be more risk-prone and may only feel they need to do something for 40% of the aircraft pairs. But, some controllers are very risk-adverse, so they may add control to over 70% of the pairs." He also mentions that as controllers become more comfortable with the understanding of the intensity number, this percentage will continue to fluctuate (Spillane, 2014).

Given Spillane's concerns about the variability in safe percentage intervention, analysis is run to consider the amount of aircraft pairs with high intensity that will require intervention at 1% through 100% at intervals of 1%. This analysis will serve to find if a threshold exists where above a certain percentage, the intensity control measure would present too high a workload for controllers, or if below a certain percentage, the controller would revert to simply monitoring the task and would not be engaged enough for appropriate situational awareness.

Finally, both controllers agree that 18 aircraft pairs needing human intervention or control would be the upper limit for the amount of aircraft pairs the a human controller could handle at once. Therefore, anything situation resulting in 19 or more critically intense aircraft pairs is considered unsafe.

Traffic Levels

Four levels of traffic and their associated intensity numbers are evaluated. These levels of traffic are current, 1.5x, 2x, and 3x. These numbers are the levels of traffic suggested by the original NextGen technology proposal that all implementable systems be able to handle.

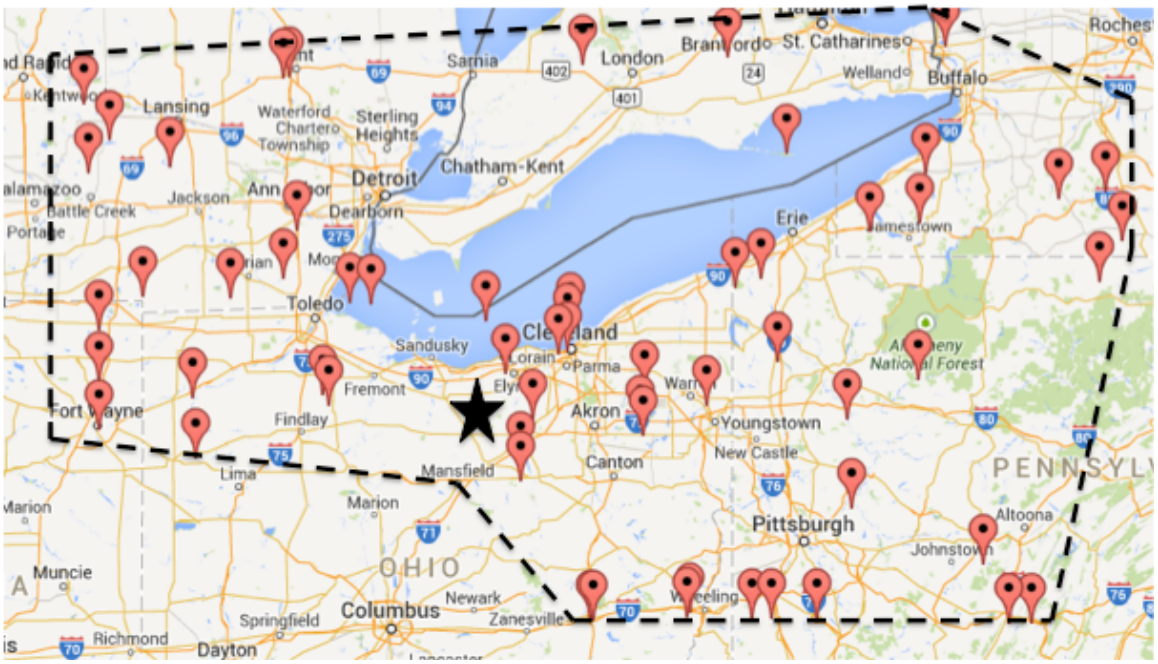


Figure 5: Area of Flight Paths at Cleveland Center

The data points to compute intensity are taken from an open-loop data run in X-Plane, where real NAS traffic data is used to build a simulation of aircraft flight paths in the Cleveland Center area, shown in Figure 5. The black star represents where Cleveland Center is located, and the red pins represent simulated flights in the area that were used for analysis. Aircraft position, speed, heading, and altitude are recorded once per second over the time period the aircraft is within Cleveland Center. This simulated traffic data contains flight information of 162 aircraft. In order to reach the desired traffic levels for each minute of analysis, 78 sets of aircraft data were utilized. One data point per minute is used for each aircraft. For this research, analysis is done on en-route, or cruising sectors of traffic. That is, data comes from Air Route Traffic Control Centers (ARTCC), and no evaluation is done on arrival, departure or TRACON traffic. Cruising traffic is defined as an aircraft flying at flight level 24,000 ft. or above. Any aircraft below 24,000 ft. at any given minute was eliminated from analysis.

As previously stated, the amount of aircraft that a controller can handle is around 12-18 aircraft. For this analysis, a sector is assumed to have a maximum of 12 aircraft while being fully handled by a human controller. At current levels of traffic, while evaluating intensity, controllers are handling around 72 distinct aircraft pairs at once, as the number of distinct aircraft pairs is defined as $n^2/2$ (Shortle & Zhang, 2014), where n is the number of aircraft per sector. At a 1.5x traffic level with a maximum of 18 aircraft per sector, there are 162 aircraft pairs, at 2x traffic level with a maximum of 24 aircraft, there are 288 distinct aircraft pairs, and at a 3x traffic level with a maximum of 36 aircraft in a sector, there are 648 distinct aircraft pairs (Figure 6).

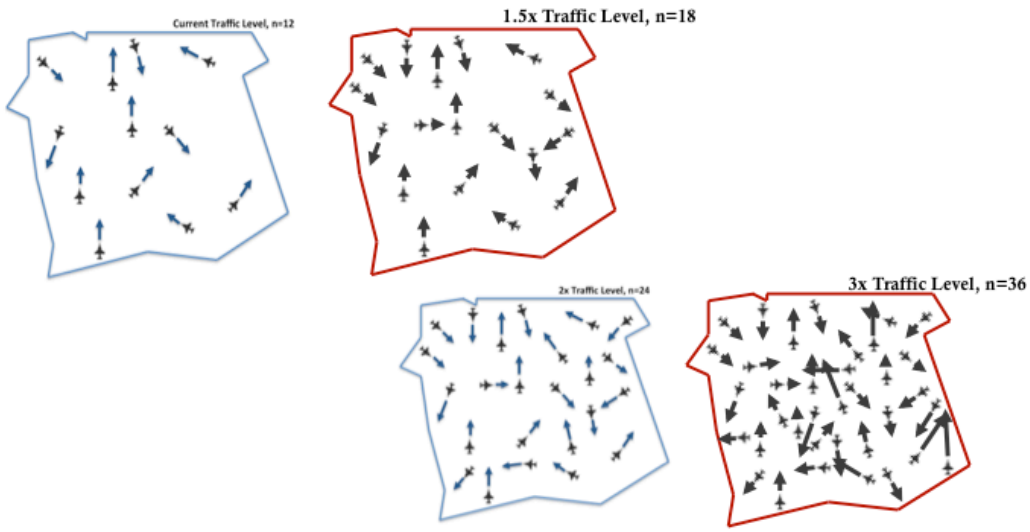


Figure 6: Traffic Levels

There is no minimum number of aircraft in each sector at the different traffic levels. The number of aircraft in each sector is determined by the order in which data was available. Therefore, some sectors have an n ranging from the traffic level maximum down to below the maximum of the previous traffic level definition. For example, the number of aircraft at any given minute during analysis of 3x traffic ranges from 21 aircraft in a minute to 36 aircraft in a minute. This kind of range in the number of aircraft, n, is a more realistic expectation of how traffic may look at increased traffic levels, as it would be impossible to guarantee that 3x traffic is always above 24 (the upper limit of 2x) but below the maximum of 36.

Data Manipulation

The raw data presented from X-Plane is not in the appropriate units of measurement for the intensity calculation. Therefore, data manipulation was required.

First, the velocity of the aircraft is presented as Mach. It is necessary for velocity to be in feet per second, so this measurement was converted by multiplying Mach by 1115.4856 to achieve feet per second.

Secondly, the location of the aircraft is given in longitude and latitude. The intensity calculation requires the aircraft position be given in respect to x and y, in feet. Longitude (which corresponds to X) and latitude (which corresponds to Y) are given in terms of meridians, both of which there are 360 of around the Earth. The earth's circumference is 21,640.6 nautical miles, and given the assumption that the Earth is a fairly perfect 360-degree circle, 1 degree (or meridian) will equal an arc of roughly 60 nautical miles (21,640.6 nm / 360 = 60.113 nm). Given this, each longitude and latitude data point is multiplied by 60 to find nautical miles for X and Y.

Additionally, the minimum of each X and Y point in each data set is taken to normalize the position points. This was done due to ensure that all location data points where positive, as the longitude around Cleveland Center is around -80 degrees. The final calculation was to go from nautical miles to feet, so the number was multiplied by 6076.12, as there are 6076.12 feet per nautical mile. The manipulations done for each data set's location points are shown in Table 1.

Table 1: Data Manipulation for Aircraft Position

	Longitude Min(after *60)	Latitude Min (after *60)	Longitude Equation	Latitude Equation
Traffic Level 1x	-5118.492	2393.158	((Long)*60 +5118.492)*6076.12	((Lat)*60-2393.158)*6076.12)
Traffic Level 1.5x	-5118.492	2354.923	((Long)*60 +5118.492)*6076.12	((Lat)*60-2354.923)*6076.12)
Traffic Level 2x	-5118.492	2353.720	((Long)*60 +5118.492)*6076.12	((Lat)*60-2353.720)*6076.12)
Traffic Level 3x	-5130.923	2353.720	((Long)*60 +5130.923)*6076.12	((Lat)*60-2353.720)*6076.12)

Data Analysis

All aircraft pairs have their intensity numbers calculated once per minute while in transit through the given sector. Evaluations of intensity numbers and the amount of critical pairs will be evaluated once a minute for forty minutes for each experimental run. While evaluating air traffic at the SOCAL TRACON for two hours, it was observed that no aircraft stayed within the sector for longer than 38 minutes or for less than 1.5 minutes. While TRACON airspace is highly trafficked, both Spillane and Snoddy confirmed that en-route traffic also follows this pattern. Therefore, the intensity number will be evaluated in the time frame of 1 to 40 minutes.

The blunder heading change (φ) will be evaluated as an array featuring heading changes of [-90°, -45°, 0°, 15°, 30°, 45°, 90°]. This range, essentially saying that the aircraft blunder would be anything ranging from a sharp left turn to a sharp right turn, is within the limits of the aircraft in the 30-second window. As the standard rate of turn for an aircraft is 180°/minute, any heading change beyond 90° in either direction from the aircraft's dead reckoning is considered unfeasible within 30 seconds. Additionally, as this analysis is dealing with en-route sectors where aircraft would be at cruising altitudes, most which are well over 30,000 feet, any turn faster than 180°/minute would most likely result in an engine stall, and is therefore high unlikely. Similarly, the blunder heading change rate ($\dot{\varphi}$), is defined as 180°/minute. The analysis factors are shown below in Table 1.

The aircraft pair data will put into the intensity formula, and given the aircraft pair current position, velocity, heading, and altitude, an intensity number will be generated for each aircraft pair. Additionally, the current lateral distance between each aircraft pair is calculated, along with the vertical distance between each pair.

Table 2: Matrix for Analysis

$$\varphi = [-90, -45, 0, 15, 30, 45, 90], \dot{\varphi} = \frac{180}{min}, HIP = 1.0, 2.5, 6.0$$

	Sector 1	Sectors 1	Sectors 1	Sectors 1
t=1				
t=2				
t=3				
⋮				
t=40				
	Current Traffic	1.5x Traffic	2x Traffic	3x Traffic

Because the intensity calculation is run where the blunder heading change is an array, the intensity numbers for each aircraft pair at a given time is an array. Therefore, the intensity number of an aircraft pair can be determined in two ways; first, the lowest intensity number, or minimum, from the array is pulled for display. This shows the most critical scenario that could occur. Second, the central tendency of all the intensity numbers in the array is calculated and displayed alongside the minimum. In this research, the central tendency number is displayed, but only the minimum intensity number from the array is used for analysis.

The addition, the central tendency value helps to establish a more holistic view of the intensity situation for each aircraft pair, and is aimed to help manage pairs more efficiently. For example, an aircraft pair may exist where the minimum intensity number is 4, which is considered critical. However, the central tendency from the array may be 11. An aircraft pair will be flagged as critical if either the central tendency or the average intensity number is 6 or below, but the large difference between the minimum and the central tendency signals to the controller that perhaps this pair is not as critical or dangerous as an aircraft pair with a minimum of 5 and an central tendency of 6.5.

The central tendency of each array is chosen for analysis, as opposed to the mean or average, because there is no guarantee that the array of intensity numbers is normal. Therefore, a central tendency, or middle point in the range, is a more appropriate measure.

The lateral distance and vertical distance between each pair is also calculated in order to eliminate any pair from being counted as a "high intensity" pair that would already be picked up as a separation assurance problem by automation. Therefore, if any aircraft pair displays a lateral distance of 18,228.36 ft. (3 nautical miles, the lowest standard for routine separation), it is not counted as "high intensity." Furthermore, if the aircraft are more than 1700 ft. apart vertically, it is not counted as high intensity. The minimum required vertical separation is 1000 ft. between aircraft, and the additional 700 ft. adds a buffer zone for additional safety.

An aircraft pair will be determined "high intensity" if it satisfies all of the following conditions.

1. The intensity number is less than the High Intensity Pair definition (1,0, 2.5, or 6)
2. The lateral distance is greater than 18,228.36 ft.
3. The vertical distance is less than 1700 ft.

Once the minimum intensity number is established at a given time=t by mathematical analysis, the intensity numbers are recorded and then recalculated and recorded for the time t=t+1 until t=40. Then, the number of high intensity aircraft pairs is recorded, and the number of pairs that would require controller intervention or assistance (c) from 1% - 100% is calculated. The percentage threshold at which more than 18 aircraft pairs would require controller intervention or assistance is also noted.

The number of HIP is evaluated to determined if human controllers are able to safely manage the number of high-intensity aircraft pairs at different traffic levels, or if a threshold exists where, above a certain traffic level, the intensity control measurement presents too many high-intensity pairs for management and renders the system unsafe. The upper threshold of aircraft a controller can handle in the current environment is around 18 (Wing et al., 2013), so 18 critical intensity aircraft pairs which require intervention will serve as the upper threshold of what is considered safe in a high traffic environment.

To address the variability and potential uncertainty around the percentage of aircraft pairs that would require intervention (Spillane, 2014), analysis is done at 1% through 100% It is possible that, at any given time, the percentage of aircraft pairs which require intervention would change as time changed (Spillane, 2014), and it is important to validate the safety of the system, if, for example, all aircraft pairs required intervention at a given time t, or if some kind of limit exists, where above some X percentage, the system becomes unsafe because the number of pairs a controller can safely handle is exceeded.

The percentage of "high" intensity aircraft pairs that require intervention does not affect the actual calculation of intensity itself; but is rather a way to measure the acceptability of the measure for controllers. Similarly, the definition of HIP (1.0, 2.5, or 6.0), which is the threshold for what is considered a "high" intensity aircraft pair, does not affect the calculation itself. Both of these numbers simply serve as a moveable barometer for the level of acceptability that controllers find in managing the intensity measure.

CHAPTER FOUR: RESULTS

Traffic Level: Current

Given current traffic levels (n≤12), over a time period of 40 minutes, and evaluated under the definition of High Intensity at 1.0, 2.5, and 6.0, the amount of High Intensity aircraft pairs (HIP) is always below 18. Therefore, the human controller would always be able to safely apply control to 100% of the HIP at any time. At current traffic levels, intensity is a task that controllers can safely manage.

When HIP is defined as a pair with an intensity number of below 1.0, the minimum number of HIP at any time is 2 and the maximum of HIP at any time is 7. Therefore, it is safe for human controllers to apply control to 100% of the HIP, 100% of the time (Figure 7). The number of HIP pairs never reaches 18 in one minute

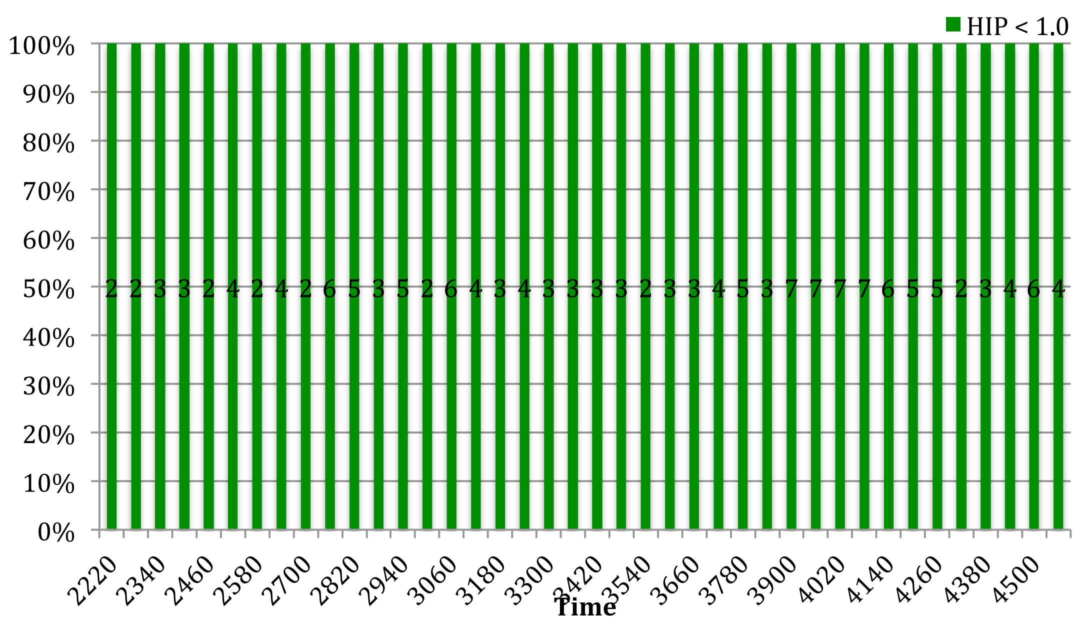


Figure 7: High Intensity Aircraft Pairs < 1.0, 1x Traffic

When HIP is defined as a pair with an intensity number below 2.5, the minimum number of HIP at any time is 2 and the maximum of HIP at any time is 10. Therefore, it is safe for controllers to apply control to 100% of HIP 100% of the time (Figure 8). The number of HIP never reaches the threshold of 18 in one minute.

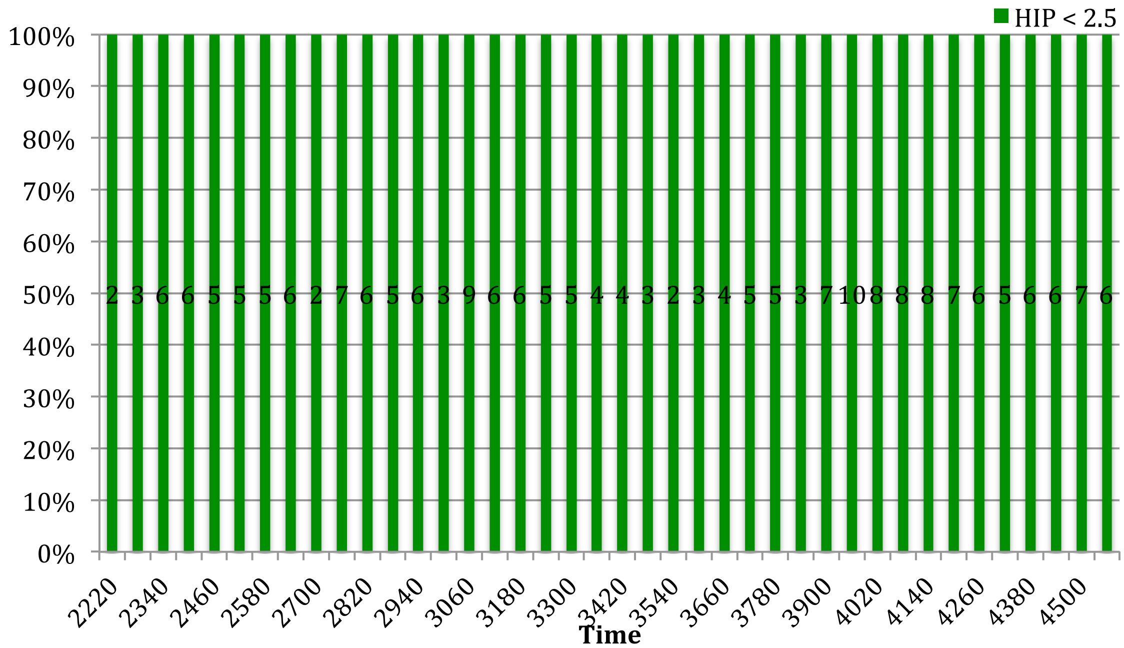


Figure 8: High Intensity Aircraft Pairs < 2.5, 1x Traffic

When HIP is defined as a pair with an intensity number of 6 or below, the minimum number of HIP at any time is 3 and the maximum number of HIP at any time is 10. Therefore, it is safe for a human controller to apply control to 100% of HIP 100% of the time (Figure 9). The number of HIP under this definition never reaches the threshold of 18 pairs in one minute.

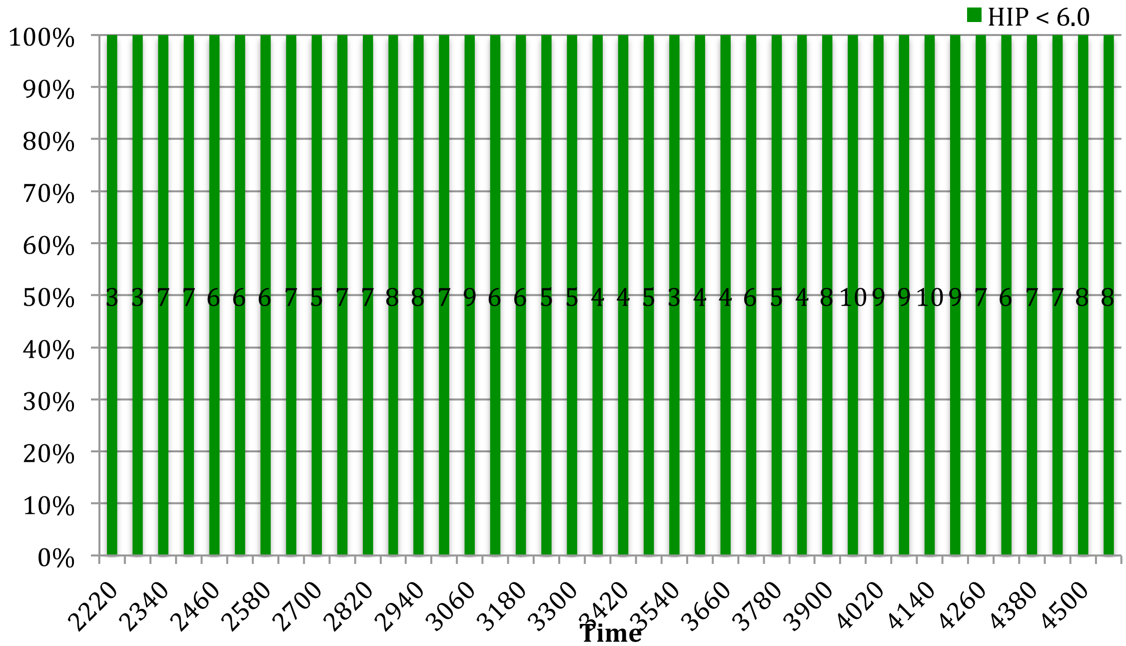


Figure 9: High Intensity Aircraft Pairs < 6.0, 1x Traffic

Traffic Level: 1.5x

Under 1.5x traffic conditions (n≤18), over a time period of 40 minutes and evaluated at HIP definitions of 1.0, 2.5, and 6.0, the amount of HIP is not always below 18. Therefore, the human controller cannot always apply control to every HIP in the sector. At the increased traffic level of 1.5x current, intensity has varying levels of manageability.

When HIP is defined as a pair with an intensity number of 1.0 or below, the minimum number of HIP at any time is 4 and the maximum number of HIP at any given time is 28. During the 40-minute period of analysis, the number of HIP exceeds the safety threshold of 18 pairs 12 times (Figure 10).

Under this definition, at a 1.5x traffic level, it is only safe to intervene with 100% of HIP 66% of the time. It is safe to intervene with 60% of HIP 100% of the time.

Figure 10: High Intensity Aircraft Pairs < 1.0, 1.5x Traffic

When HIP is defined as a pair with an intensity number of 2.5 or below, the minimum number of HIP at any time is 9 and the maximum number of HIP at any time is 39. During the 40 minute time period of analysis, the number of HIP in a minute exceeds the safety threshold of 18 pairs 31 times (Figure 11).

Under this definition at 1.5x, human controllers can safely apply control to 100% of HIP only 22.5% of the time. At 60% of HIP intervention, 77.5% of HIP can safely have control applied by human controllers. It is always safe to intervene with 46% of HIP at any time.

When HIP is defined as a pair with an intensity number of 6.0 or below, the minimum number of HIP at any time is 11 and the maximum number of HIP at any time is 41. During the 40 minute time period of analysis, the number of HIP in a minute exceeds the safety threshold of 18 pairs 36 times (Figure 12).

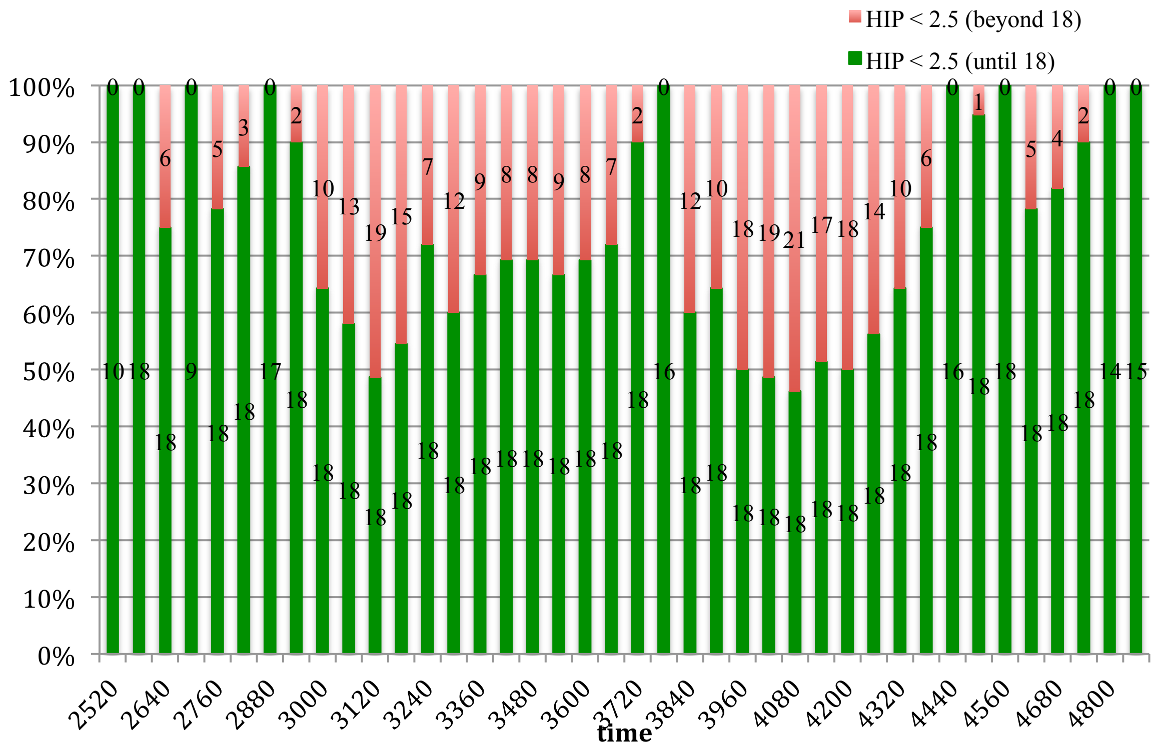


Figure 11: High Intensity Aircraft Pairs < 2.5, 1.5x Traffic

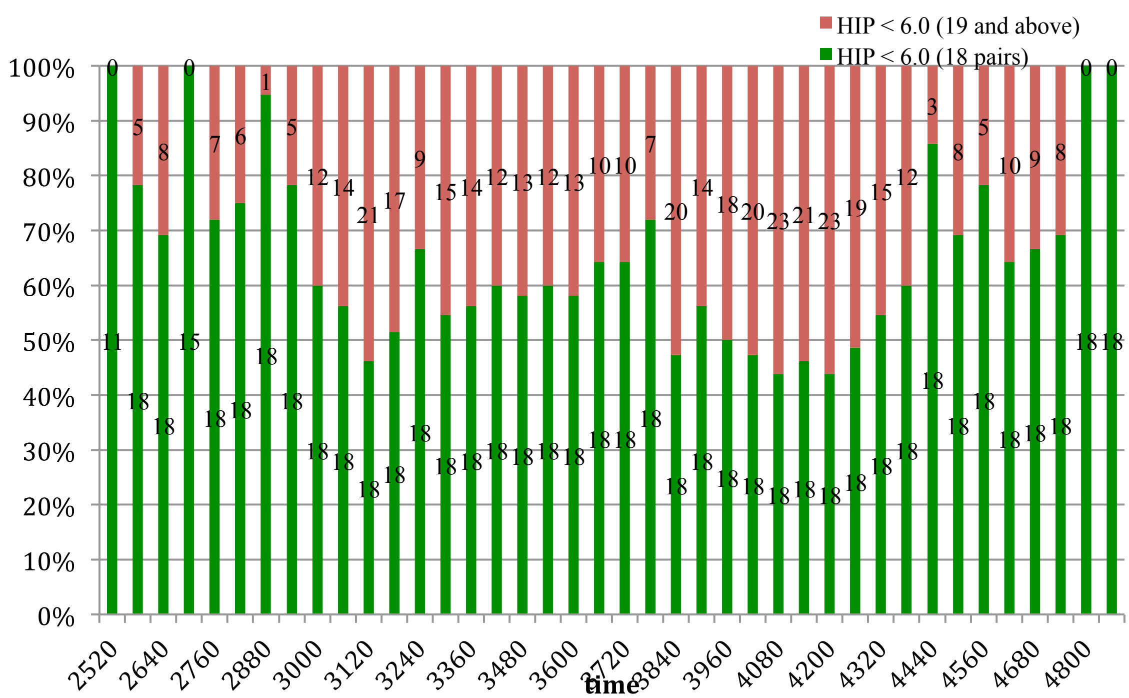


Figure 12: High Intensity Aircraft Pairs < 6.0, 1.5x Traffic

Under this definition at 1.5x, human controllers can safely apply control to 100% of HIP only 22.5% of the time. At 60% of HIP intervention, 77.5% of HIP can safely have control applied by human controllers. It is always safe to intervene with 46% of HIP at any time.

When HIP is defined as a pair with an intensity number of 6.0 or below, the minimum number of HIP at any time is 11 and the maximum number of HIP at any time is 41. During the 40 minute time period of analysis, the number of HIP in a minute exceeds the safety threshold of 18 pairs 36 times (Figure 12).

Under this definition at 1.5x traffic, human controllers can safely apply control to 100% of HIP 10% of the time. At 60% of HIP intervention, 60% of HIP can safely have control applied to them by human controllers. It is always safe to intervene with 43% of HIP at any time.

Traffic Level: 2x

Under 2x traffic conditions ($n \leq 24$), over a time period of 40 minutes and evaluated at HIP definitions of 1.0, 2.5, and 6.0, the amount of HIP is not always below 18. Therefore, the human controller cannot always apply control to every HIP in the sector. At the increased traffic level of 2x current, intensity has varying levels of manageability.

When HIP is defined as a pair having intensity of 1.0 or below, the minimum number of HIP at any given time is 15 and the maximum number of HIP at any given time is 44. During the 40 minute time period of analysis, the number of HIP exceeds the safety threshold of 18 pairs 38 times (Figure 13).

Under this definition of HIP at 2x traffic, it is safe for human controllers to apply control to every HIP only 5% of the time. At an intervention rate of 60%, it is safe for controllers to apply control to 42.5% of HIP. It is always safe to intervene with 40% of HIP.

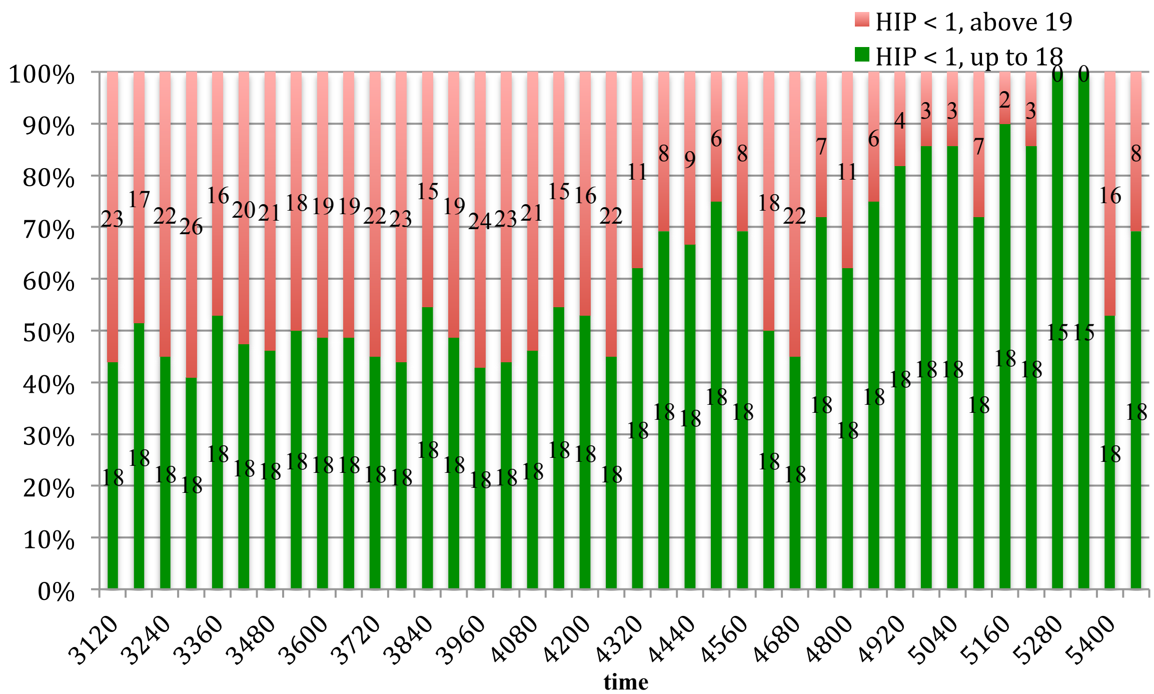


Figure 13: High Intensity Aircraft Pairs < 1.0, 2x Traffic

When HIP is defined as a pair having an intensity number of 2.5 or below, the minimum number of HIP at any given time is 25 and the maximum number of HIP at any given time is 65. During the 40 minute time period of analysis, the number of HIP exceeds the safety threshold of 18 pairs per minute 40 times (Figure 14).

Under this definition of HIP at 2x traffic level, it is never safe for human controls to apply control to every HIP. At a 60% intervention rate, it is only safe for controllers to apply control 5% of the time. It is always safe for controllers to intervene with 27% of HIP.

When HIP is defined as a pair with an intensity number of 6.0 or less, the minimum number of HIP at any given time is 34 and the maximum number of HIP at any given time is 73. During the 40 minute time period of analysis, the safety threshold of 18 pairs per minute is always exceeded (Figure 15).

Under this definition of HIP at 2x traffic level, it is never safe for humans to apply control to every HIP. At a 60% intervention rate, it is never safe for controllers to apply control to all HIP. It is always safe for controllers to apply control to 24% of HIP.

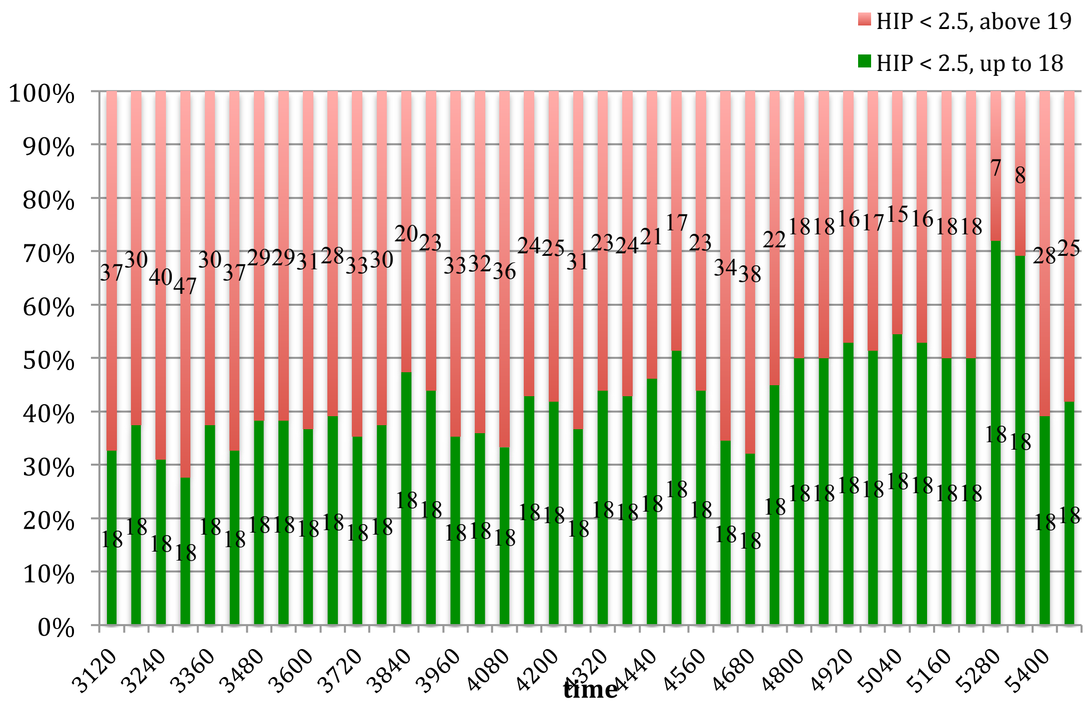


Figure 14: High Intensity Aircraft Pairs < 2.5, 2x Traffic

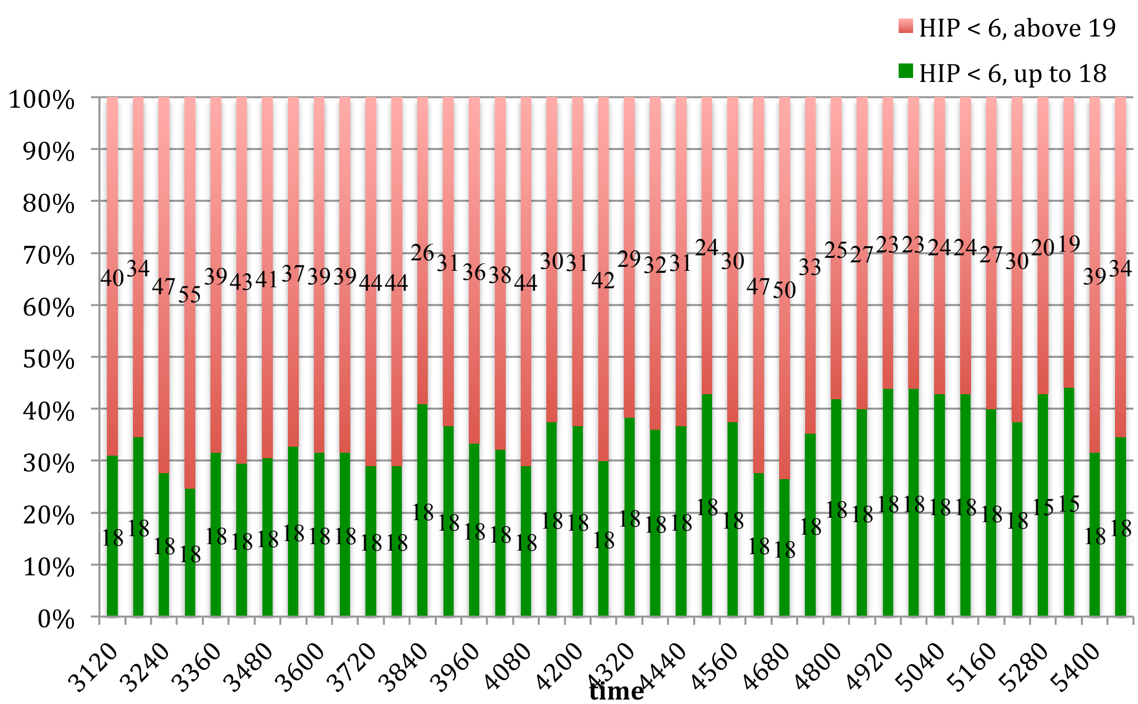


Figure 15: High Intensity Aircraft Pairs < 6.0, 2x Traffic

Traffic Level: 3x

Under 3x traffic conditions (n≤36), over a time period of 40 minutes and evaluated at HIP definitions of 1.0, 2.5, and 6.0, the amount of HIP is not always below 18. Therefore, the human controller cannot always apply control to every HIP in the sector. At the increased traffic level of 2x current, intensity has varying levels of manageability.

When HIP is defined as a pair with an intensity number of 1.0 or less, the minimum number of HIP at any time is 29 and the maximum number of HIP at any time is 105. During the 40 minute time period of analysis, the number of HIP always exceeds the safety threshold of 18 pairs per minute (Figure 16).

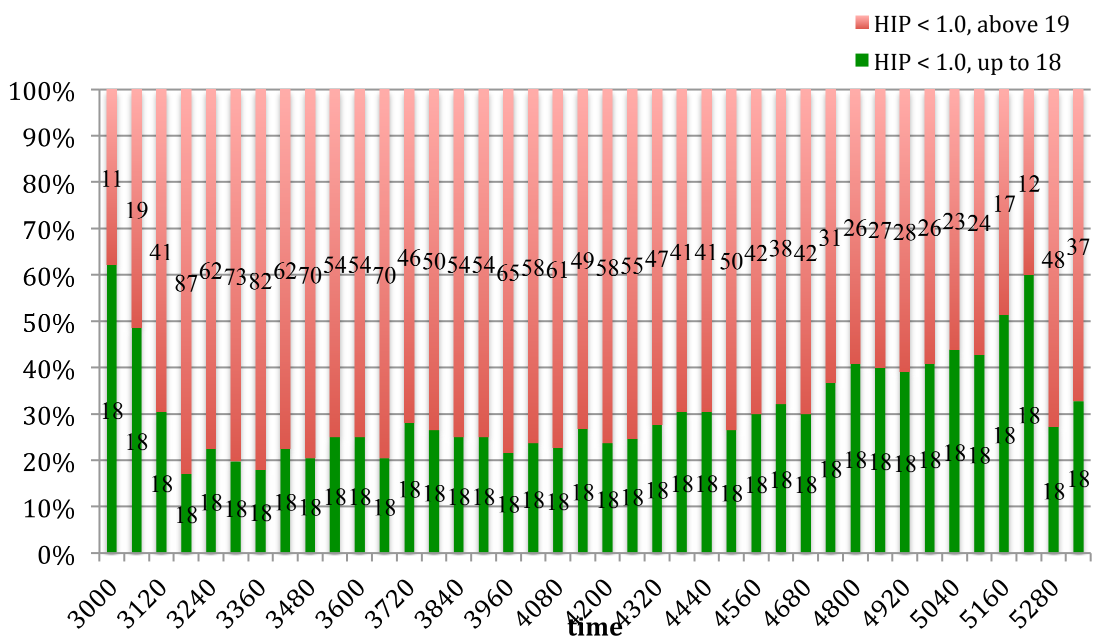


Figure 16: High Intensity Aircraft Pairs < 1.0, 3x

Under this definition of HIP at a 3x traffic level, it is never safe for controls to always apply control to every HIP. It is safe for controllers to intervene with 60% of HIP only 5% of the time. It is always safe for controllers to apply control to 18% of HIP.

When HIP is defined as a pair with an intensity number of 2.5 or below, the minimum number of HIP at any time is 47 and the maximum number of HIP at any time is 130. The amount of HIP per minute always exceeds the safety threshold of 18 pairs per minute (Figure 17).

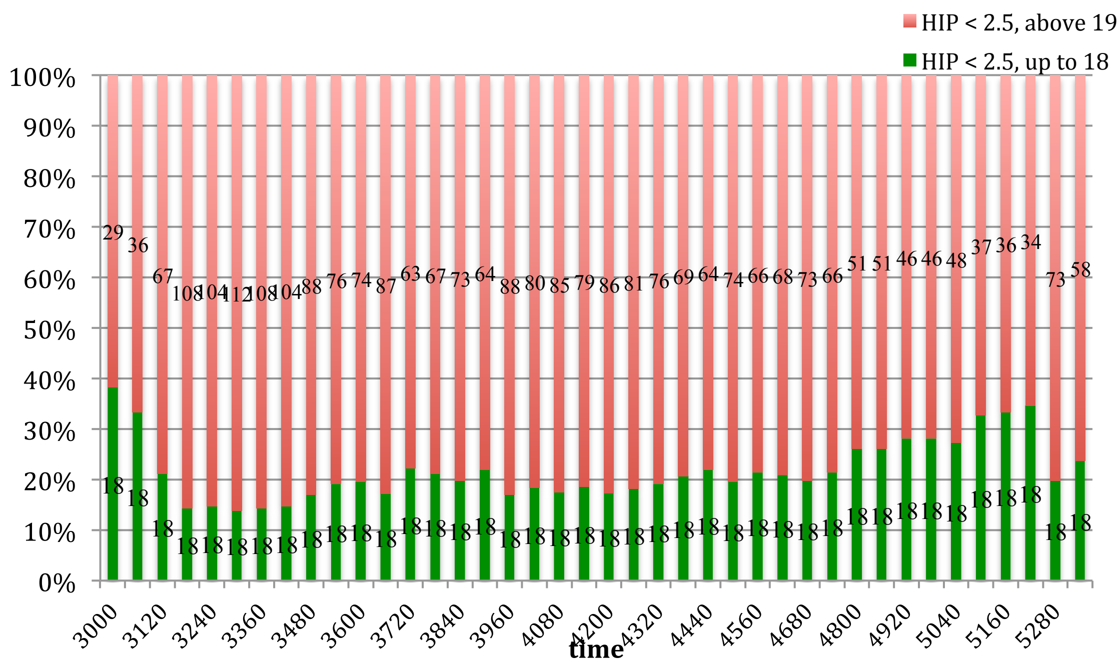


Figure 17: High Intensity Aircraft Pairs < 2.5, 3x Traffic

Under this definition of HIP at 3x traffic, it is never safe for controllers to apply control to every HIP. It is never safe for controllers to apply control to 60% of HIP. It is always safe for controllers to apply control to 13% of HIP.

When HIP is defined as a pair with an intensity number of 6.0 or below, the minimum number of HIP at any time is 51 and the maximum number of HIP at any given time is 142. The number of HIP per minute always exceeds the safety threshold of 18 pairs per minute (Figure 18).

Under this definition of HIP at 3x traffic, it is never safe for controllers to apply control to every HIP. It is never safe for controllers to apply control to 60% of HIP. It is always safe for controllers to apply control to 12% of HIP.

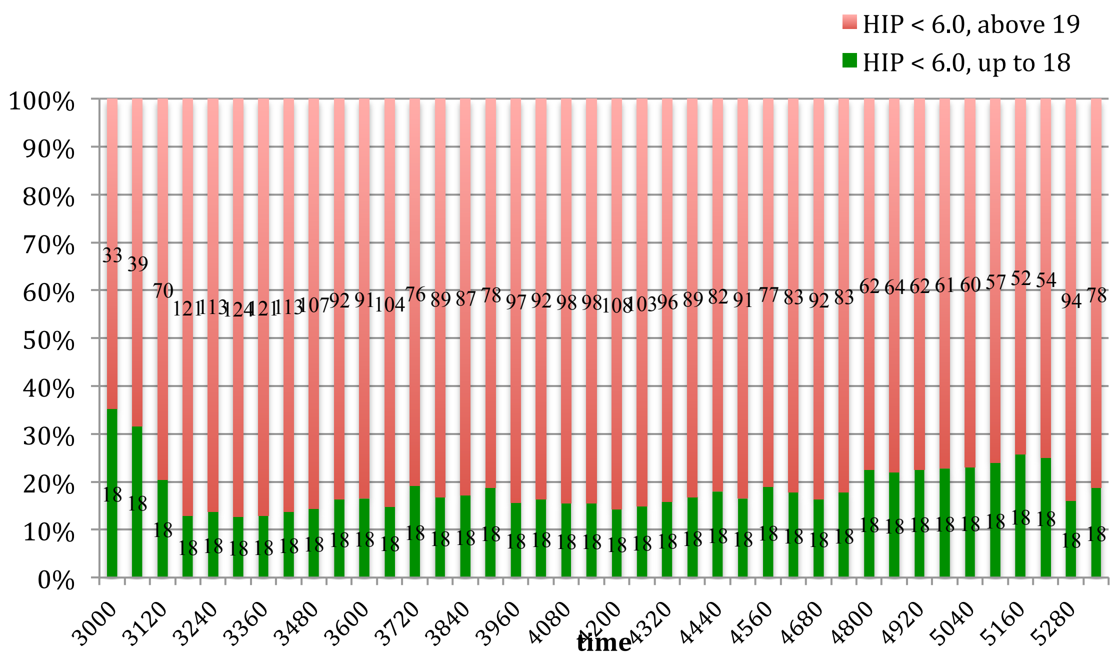


Figure 18: High Intensity Aircraft Pairs < 6.0, 3x Traffic

Safe Intervention Level

Safe intervention level is defined as the percentage of all aircraft pairs in any given minute that contains 18 or less HIP. That is, if the safe intervention level is 42%, then 18 HIP pairs are 42% of the overall number of HIP in that time period.

The safe intervention level in each minute is shown to be normally distributed across the 4 traffic levels, but variance is high within each traffic level. Therefore, while it is clear that the safe intervention level decreases as the traffic level increases (Figure 19), the best-fit line of the combined data is poor, and no predictive model can be drawn from this data (Figure 20).

However, 95% confidence intervals found using a nonparametric 1-sample sign test show that at 1.5x traffic, it is 95% probable that the percentage of safe intervention will be between 69.00% and 81.81%. For 2x traffic, it is 95% probable that the percentage of safe intervention will be between 40% and 45%. For 3x traffic, it is 95% probable that the safe intervention level will be between 19% and 22% (Appendix B). Current traffic levels are not analyzed as they always have a safe intervention level of 100%.

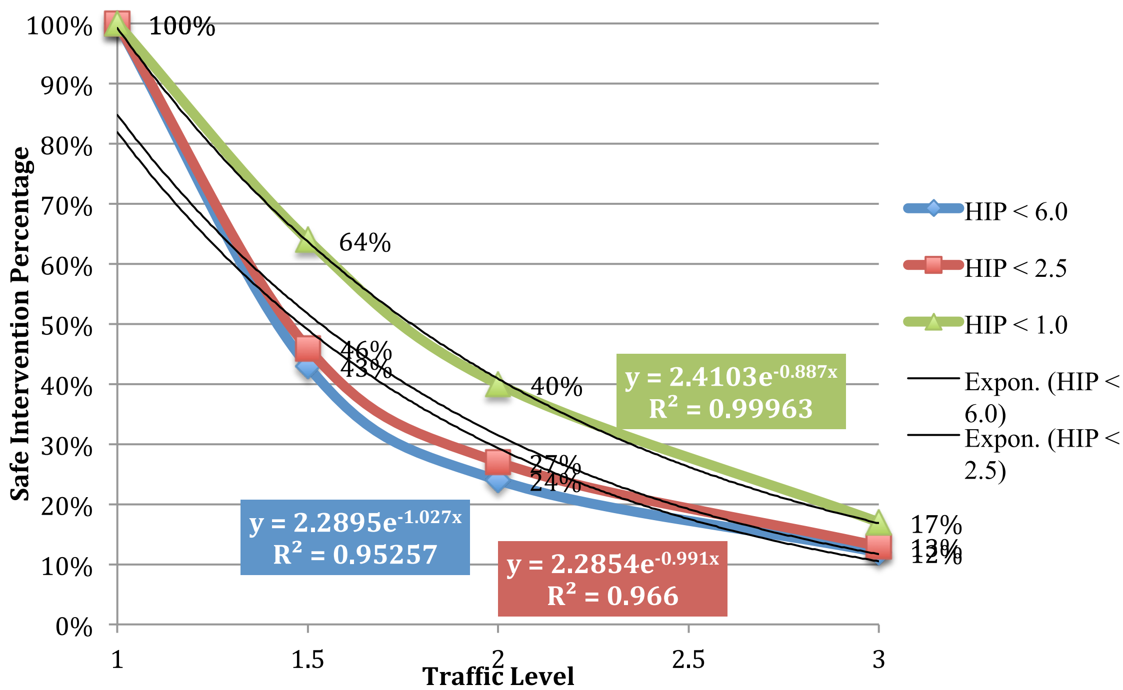


Figure 19: Safe Percentage of Intervention by Traffic Level

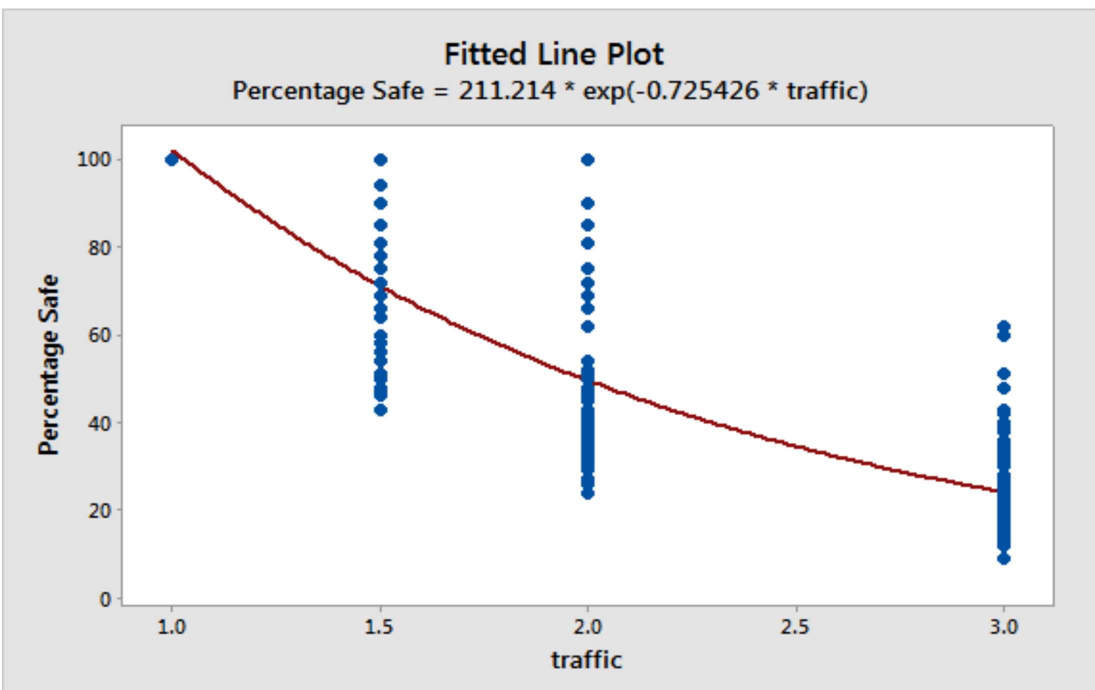


Figure 20: Fitted Line Plot of Traffic Level vs. Safe Percentage Level

At traffic levels 1.5x and 2x, it is possible to reach a safe intervention level of 100%, but at 3x, under these conditions, it does not appear possible to reach a safe intervention level of 100%.

It is necessary to use nonparametric methods to find confidence intervals in this analysis because the data violates the assumptions of traditional statistics. Since the data is not normal (Appendix B) and there is non-constant variance, both of which are assumptions of ANOVA, t-tests, and regression analysis, utilizing nonparametric measures is best. Nonparametric tests do not assume normality or constant variance. The nonparametric test used here in Minitab uses a one-sample test sign, which also does not assume symmetry. This method does have limitations, as it tends to be less powerful than a t-test with normality and it tests the population around the median instead of the mean. The test itself performs analysis and provides a p-value based on a binomial distribution.

Number of HIP per minute

The analysis of data shows that the number of HIP per minute increases as traffic levels increase (Figure 21). It appears that the relationship between traffic level and the number of HIP/minute is non-linear, and best-fit lines for each data set given by HIP definition reveals a power relationship. That is, the number of HIP/minute increases by a power of about 2.5 as the traffic level increases. However, the fitted line plot of the combined data (Figure 22) shows that the predictive model is poor, as most data points is poorly fit to the line. Additionally, the data proves to be non-normal with non-constant variance, so no predictive model is appropriate (Appendix B).

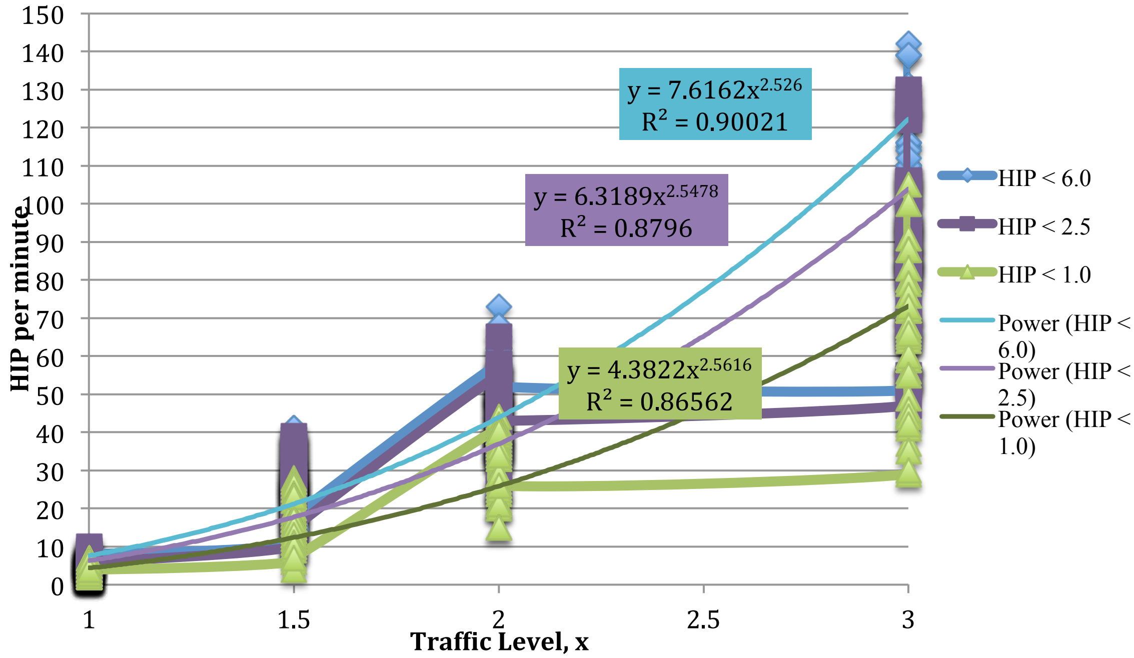


Figure 21: HIP per minute by Traffic Level

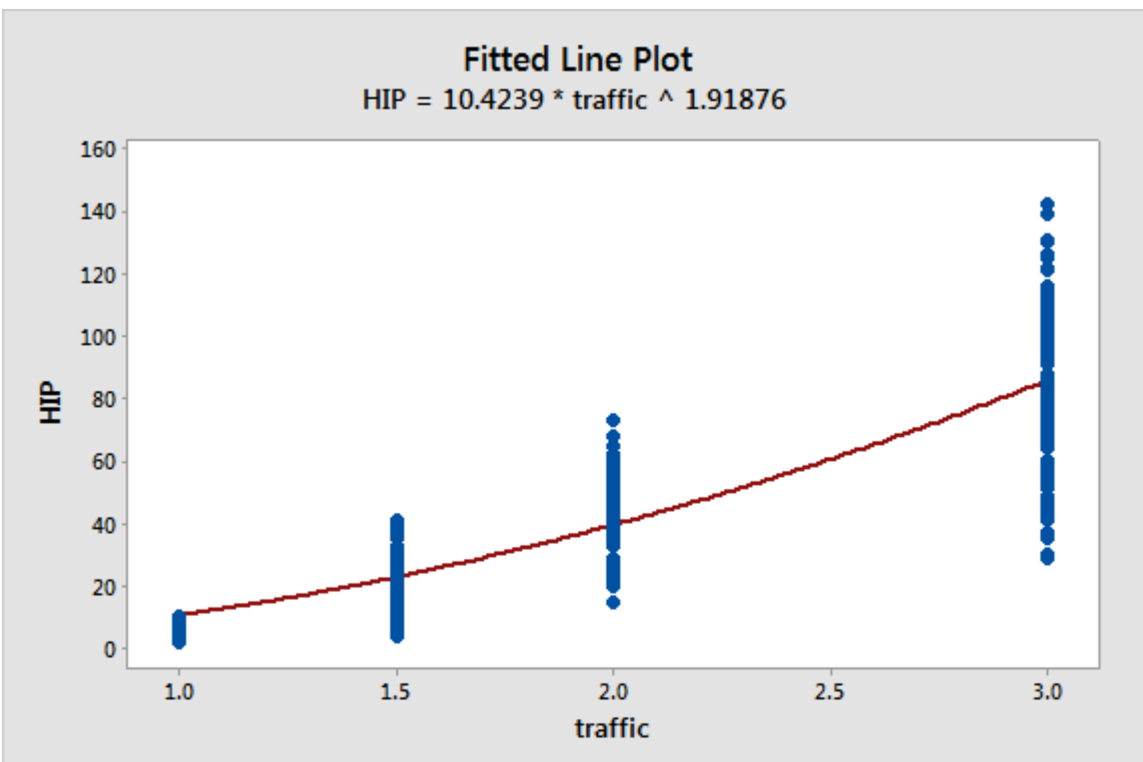


Figure 22: Fitted Line Plot for HIP/minute and Traffic Level

Due to the non-normality of data (Appendix B), it is necessary to use nonparametric analysis to find confidence intervals for the number of HIP/minute based on traffic level. At 1.0x/current traffic level, it is 95% probable that the number of HIP/minute will fall between 5 and 6. At 1.5x traffic level, it is 95% probable that the number of HIP/minute will fall between 21 and 26. At 2x traffic level, it is 95% probable that the number of HIP/minute will fall between 40 and 45. At 3x traffic level, it is 95% probably that the number of HIP/minute will fall between 79 and 91 (Appendix B).

Number of HIP per minute and Number of Aircraft (n) per minute

Further analysis of the data shows the number of HIP per minute increases when the number of aircraft (n) in that minute increases. The relationship between the number of HIP per minute and n appears to be linear or potentially a quadratic polynomial from the scatterplot (Figure 23).

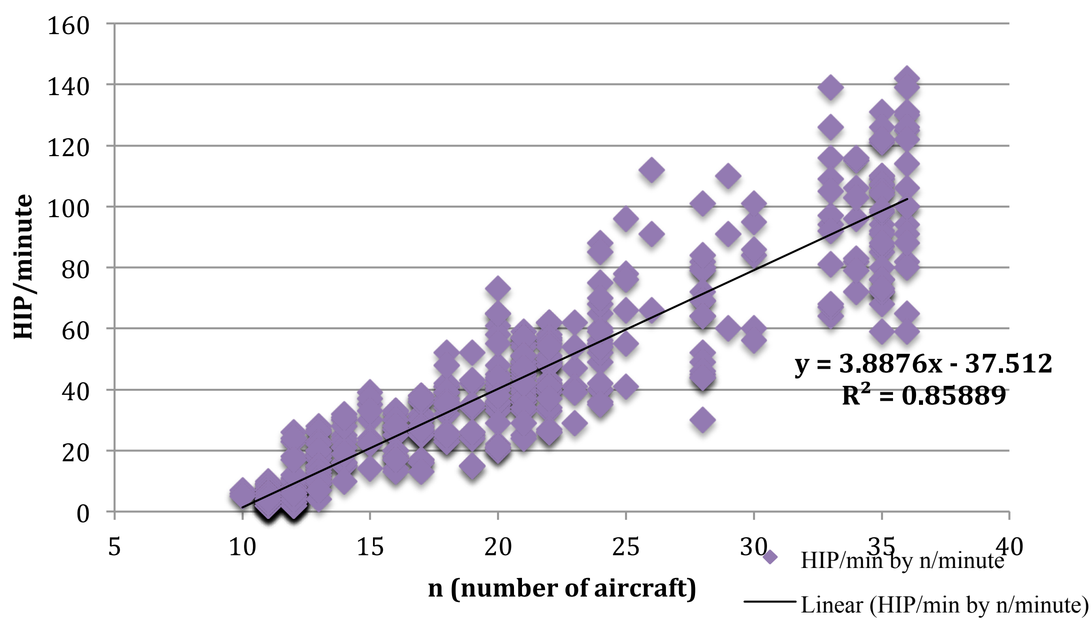


Figure 23: Number of HIP/minute by n/minute

Linear regression analysis reveals the number of HIP/minute by n/minute to have a poor fit towards the data points, as well as non-normal and containing non-constant variance (Figure 24). Therefore, the regression model is not predictive to determine how many HIP/per would occur when a sector were to have n aircraft present.

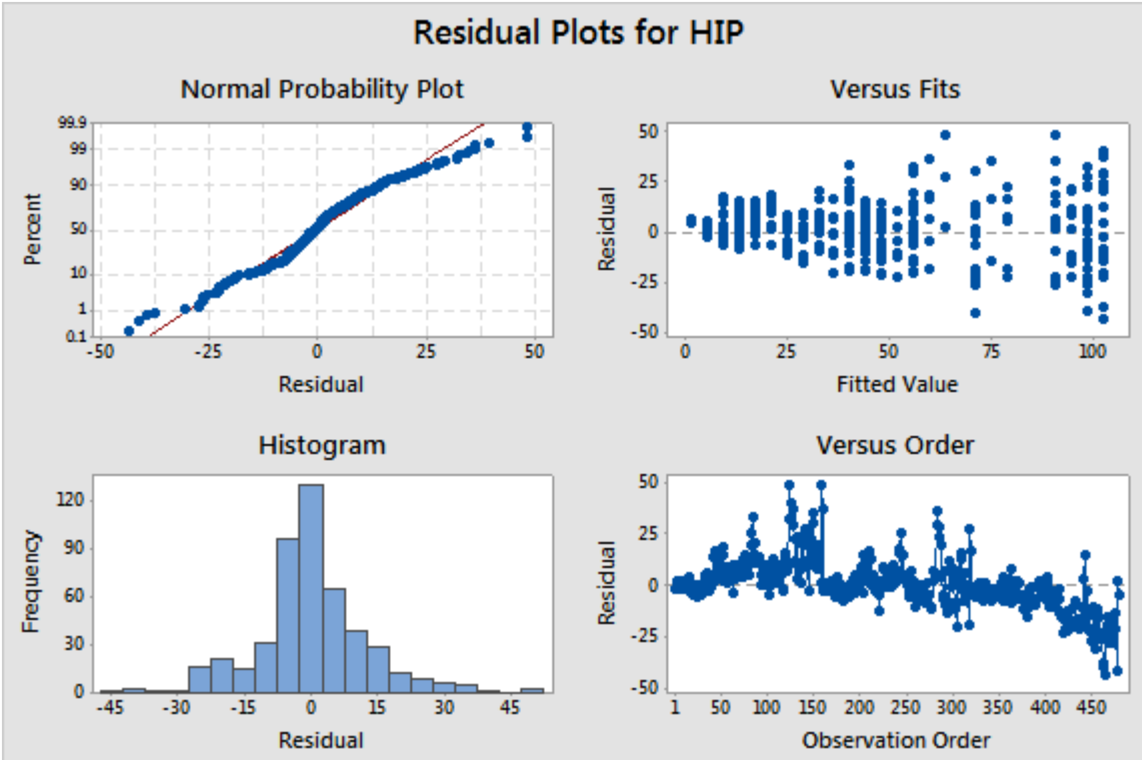


Figure 24: Regression plots for number of HIP/minute by n/minute

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

Discussion

HIP Percentage Intervention + Traffic Levels

The analysis of high intensity aircraft pairs in an area with a variety of traffic levels yielded several unexpected insights into the development of the intensity measure.

First, it appears that this would be an implementable task for controllers in the current 1x traffic level environment from a workload perspective. The amount of HIP never exceeds the workload limit of 18 per minute over the course of 40 minutes, regardless of the definition of HIP (1,0, 2.5 or 6.0). Controllers would be able to apply control to 100% of HIP at all times. Due to the static nature of the analysis, it is unknown how applying control would affect the amount of HIP per minute.

For 1.5x traffic levels, results vary greatly by the definition of HIP. When HIP is defined as any aircraft pair with an intensity number of 1.0 or less, the number of HIP exceeds 18 in 12 different minutes. It is worth noting that these times where the number of HIP exceeds controller workload capability happen in clusters. It may be possible that when control is applied in a dynamic environment, these overly loaded minutes would resolve by the actions of the controller and the subsequent minutes would then no longer be unsafe for controllers to manage. In the current static analysis though, the controllers could safely intervene with 64% of HIP at all times.

When HIP is defined as 2.5 or less at 1.5x traffic, the results begin to shift drastically. Here, the number of times when HIP exceeds the safety limit of 18 is 32 different minutes. It would be safe for controllers to intervene with only 46% of HIP at any given minute. Again, the application of dynamic control may resolve many of these HIP. While the aircraft are moving in this static analysis, once a HIP appears, it seems to remain a HIP for some time. Some HIP seem to eventually resolve themselves over time, but dynamically applied control may decrease the amount of time that an aircraft pair is a problem for controllers.

When the definition of HIP is moved down to 6.0 at 1.5x traffic, results continue to deteriorate. Here, it is safe for controllers to apply control to just 43% of HIP at any time. The number of minutes that the number of HIP exceeds 18 is now 36 minutes. There is not a drastic difference between the percentages of controllable HIP at the definitions being 2.5(46%) and 6 (43%), in contrast with the difference between 1.0(64%) and 2.5(46%). This suggests that a large proportion of HIP have intensity numbers ranging between 1 and 2.5, and that only a small number reside in the 2.6 to 6.0 ranges.

When the traffic level increases to 2x, similar results are shown. When HIP is defined as 1 or below, controllers can safely apply control to 40% of HIP at any time. When HIP is defined as 2.5, that percentage drops largely to 27%, and when HIP is defined as 6.0, the percentage only drops to 24%. These results continue to suggest that the amount of aircraft pairs with an intensity number between 2.6 and 6.0 is very small.

At 3x traffic levels, the results further suggest this trend. When HIP is defined as 1.0 or less, the percentage of HIP that controllers can apply intervention towards at all times is only 17%. When HIP is defined as 2.5 or less, that percentage drops to 13%, and when HIP is 6.0 or less, that percentage is only 12%.

This evidence suggests that the difference between defining HIP as 2.5 and 6.0 or below may be negligible, and that the majority of HIP have intensity numbers between 0 and 2.5.

Statistical analysis shows that there is very little relationship between the percentages of HIP that are always safe to intervene with and the definition of HIP. A linear regression analysis, chosen because scatterplot data did not reveal any evidence of a quadratic, cubic, or exponential relationship, in Minitab shows that a fitted line amongst the data provides a standard error of S=34.6031, a p-value of 0.658, and an R-Squared value of 0% (Figure 30). Therefore, there is no statistically significant relationship between the percentage of safe intervention of all HIP pairs and the definition of HIP.

Number of HIP/minute and Traffic Level

The number of HIP/minute increases as the traffic level increases, as expected. However, analysis of the relationship between the number of HIP/minute increases by a power of 2.5 as the traffic level increases. Regression analysis reveals no well-fit model for the data (Appendix B), but many interesting observations are drawn from the analysis that helps further the understanding of intensity.

High, Non-Constant Variance

The mean of the response variable, the number of HIP/minute, with respect to traffic levels, has a non-constant level of variance that increases dramatically as the traffic level increases. Descriptive statistics of HIP/minute with respect to traffic level is shown below.

Variable	Traffic	N	N*	Mean	SE Mean	StDev	Variance
HIP/minute	1.0	120	0	5.225	0.188	2.060	4.243
	1.5	120	0	23.317	0.784	8.592	73.815
	2.0	120	0	42.52	1.10	12.02	144.54
	3.0	120	0	84.84	2.39	26.15	683.98

The level of variance increases by a power of roughly 4.4 as the traffic level increases. The number of n increasing in each traffic level, and therefore the number of unique pairs increasing can explain the dramatic increase in variance. The number of pairs increases by the function of $n^2/2$, so as n increases from a maximum of 24 aircraft at 2x, where the number of unique aircraft pairs is 288, to a maximum of 36 aircraft at 3x, where the number of unique aircraft pairs is 648. This is a 225% increase in the number of unique aircraft pairs. This increase drives a significantly higher number of pairs which are eligible to be labeled as HIP. Additionally, the increased number of aircraft in the same amount of space will naturally lead to more HIP.

Another source of the high levels of non-constant variance are the ranges of n in each analysis. The minimum and maximum of aircraft being evaluated in each traffic level analysis is shown in table 3.

Table 3: Aircraft n and unique pair min/max by traffic level

	Minimum n	Minimum unique pairs	Maximum n	Maximum unique pairs
Current Level	10	50	12	72
1.5x	12	72	18	162
2x	17	145	24	288
3x	21	221	36	648

The number of unique pairs for analysis only increases by 44% from minimum to maximum n at the current traffic level. At 1.5x, the number of unique pairs increases by 55.5%, and at 2x, it increases by 49.6% from minimum to maximum n. However, at 3x, the number of unique pairs for analysis increases by 65.8% from minimum to maximum n. These increases account for the reason the variance is much higher at 3x than it is at current, 1.5x and 2x.

The large range of n at 3x is indicative of the reality of what this kind of traffic increase may look like. It is entirely possible that at any given minute, there may be only 21 or 22 aircraft in the sector, but five or six minutes later, there may be 32 aircraft in the sector, or even 36 aircraft. This jump is large, causing the number of unique pairs for analysis to skyrocket, but it is feasible.

Additionally, the relationship between the difference of maximum and minimum pairs at a traffic level and its corresponding variance display a quadratic relationship. That is, as the difference between the maximum and minimum pairs increase, the variance also increases (Appendix B). The cause of the relationship is unknown but should be examined.

It is necessary to weight the non-linear regression of HIP/minute and traffic level in order to manage the non-constant variance. Weighting the data with 1/(# of HIP/minute) for each data point is chosen because while the wide range of n is causing the non-constant variance, it is actually the high, non-constant variance of the number of HIP/minute that is causing the problem in the regression. Therefore, weighting the analysis with the inverse of HIP/minute helps to cancel out the heavy effect of the larger HIP/minute data points.

Weighting the non-linear regression analysis does cause the standard error of the model to decrease drastically, but the model is still poorly fit to the data. Additionally, the data for HIP/minute at 1.5x, 2x, and 3x are not normal, and therefore regression model is not applicable.

HIP/minute by N/minute

The number of HIP/minute by the number of aircraft (n)/minute provides an interesting level of granularity by which it is possible to further analyze the source of the data's non-constant variance. The relationship between the number of HIP/minute and the number of aircraft (n) present in the sector at that time are is linear or potentially quadratic, however, non-constant variance and non-normality of the data yield the original regression model inappropriate due to regression assumption violation.

Despite the regression assumptions being violated, it is more valid to notice that the regression equation does not fit the data points very well. This shows that the model itself is not very predictive.

It is possible to perform a Box-Cox Transformation on the response (the number of HIP/minute). Box-Cox Transformations, also known as power transformations, are used to stabilize variance in order to improve the validity of statistical analysis such as regression, and also improves normality in many cases. A Box-Cox transformation is performed on the response using a power parameter lambda = 0.39, chosen as optimal by

Minitab (Appendix B). This transformation does improve the variance of HIP/minute, making it more constant, and the normality appears to improve as well. However, the fit of the data points to the line does not improve, and despite the transformative measures, the line continues to be non-predictive. The transformation does not solve the problem of non-constant variance and non-normality, but rather covers it up.

The descriptive statistics however do show areas of interest. At varying levels of n, the variance in the number of HIP/minute is non-constant. However, some levels of n experience much higher variance than others (Appendix B). For example, when n=20, the variance is 212.28, but when n=18, the variance is only 71.52. There appears to be some interesting properties of the aircraft traffic when n=20, and further investigation of what is causing such high variance at n=20 may yield important insights into how the measure of intensity behaves with live traffic. Particular aircraft numbers (n) of note are n=15, 19, 20, 23, 24, 26, 29, 33, 36. These levels of n all have variances that behave different than those around them (Appendix B).

Since the regression analysis is not valid in predicting how many HIP/minute will occur at varying levels of n, it is useful to use quartiles. When n=20, the minimum is 20, the first quartile is 33, the median is 40, the third quartile is 48, and the maximum is 73. That means the highest 25% of the number of HIP/minute when n=20 falls between 48 and 73. The highest 50% of the number of HIP/minute when n=20 falls between 40 and 73, and the highest 75% of the number of HIP/minute when n=20 falls between 33 and 73. These quartiles are more predictive in helping to determine how many HIP/minute to expect at a given level of aircraft traffic.

Intensity Model Variables

The definition of intensity states that the number itself refers to the amount of time until, if either aircraft in a pair blunders, the agents of the system would have 30 seconds or less to detect and resolve a NMAC. However, the "30 seconds or less" portion of that definition is malleable and changing that time frame may result in a change of the HIP per minute, especially at 3x traffic levels.

It is interesting to note that at current, 1.5x, and 2x, it is possible to reach a point where the number of HIP is 18 or below. At 3x, however, this does not occur. For example, at 2x, when HIP is defined as 1.0 or below, 18 or fewer HIP occur in two separate minutes. These two instances may reveal some interesting properties about the kind of traffic that yields less HIP pairs, which in turn may help determine a more appropriate time frame for the definition of intensity.

Additionally, it is possible that, given the 30-second threshold, a large number of HIP exist at 31 or 32 seconds. These HIP existing at 31 seconds would most likely be just as intense and potentially dangerous as those within the 30-second limit, but they would be excluded. Therefore, computing intensity with a range of time, such as from 30 to 40 seconds, as the threshold, may yield a safer and more appropriate measure to be monitored and managed.

Limitations

Many limitations exist in this research surrounding the development of the intensity control measure. A formal threshold for what is considered to be a critical intensity number has not yet been established. Further experimentation using human air traffic controller subjects is necessary to formally establish this threshold, utilizing both performance data and subjective interviews. Once candidate threshold numbers are established, the methodology used here can be applied to additional sets of data for reanalysis using the adjusted threshold for what is considered a high-intensity number for an aircraft pair. This may affect the number of HIP that occur per minute, and may therefore affect the model for HIP/minute.

Furthermore, the percentage of high-intensity aircraft pairs that require intervention is not formally defined. In reality, this number may be higher or lower, depending on the situation. This experiment does test what the number of critical aircraft pairs requiring intervention is at different percentages, but a formal definition is lacking. The analysis at different levels may reveal a kind of threshold where above a certain percentage of flight pairs that need invention, the workload would be too high for controllers to handle, or too low to ensure engagement by controllers, but it is also possible that a formal definition may be impossible, as the percentage of aircraft which require intervention may change in a continuous fashion over time, and is not discrete.

Additionally, this analysis is static. That is, it does not account for changes in intensity numbers that would occur for each aircraft pair in the sector if a trajectory or flight level change was made in the event of controller intervention. The analysis is only based on if aircraft continued uninterrupted on their planned route with no changes applied over the 40 minutes of time in the sector. In implementation, the controllers will intervene and make changes to an aircraft's trajectory in order to manage intensity away from criticality, and therefore the number of high intensity aircraft pairs may stabilize or change in a different way.

This work does not address the possibility of a distributed function among agents. It is possible that the monitoring intensity numbers could be distributed between pilots via data link or some kind of display in the cockpit and controllers on the ground. Previous work has been done to show that automated separation assurance may have lower variance in the number of separation losses if the work is distributed amongst pilots instead of centralized on the ground (Shortle & Zhang, 2014) (Wing et al., 2013). While this previous work does not account for any human-controller tasks, further work would be necessary to determine if a shared responsibility for monitoring intensity control numbers between agents would result in a higher level of safety, as actual implementation of a shared responsibility or self-separating aircraft is questionable due to workload factor and complexity (Spillane, 2014).

Conclusions

Given the results, the intensity control measure is not a safe, implementable task for human controllers to manage with increased traffic at this time. At current traffic levels, it is a manageable task with a safe level of HIP at all times. However, at increased traffic levels, the number exceeds the safety threshold of 18 HIP/minute or less, and would not be manageable at all times.

Additionally, it is clear that the initial hypothesis defining HIP as any aircraft pair with an intensity number of 6.0 or below definition of HIP may need to change as traffic levels increase in order to supply a manageable workload to controllers. Furthermore, the time frame in the definition of intensity (30 seconds or less) may need to be changed in order to supply controllers with an appropriate task that is safe to manage and monitor.

While the analysis shows that under the given circumstances, intensity is not a safe measure to use at increased traffic levels, valuable insights are drawn from the data. The number of HIP/minute increases by a power of 2.5 as traffic levels increase. Because the data is non-normal and contains non-constant variance throughout, regression models are not appropriate, however, confidence intervals provide insight into where a majority of data points would be expected to fall. Additionally, a quadratic relationship is shown between the difference of the maximum and minimum aircraft pairs that exist at a given traffic level and the variance in the number of HIP. A linear or potentially quadratic relationship is also shown between the number of aircrafts in a sector at a given minute and the number of HIP present at that time. The variance in the number of HIP/minute plays a role in defining these relationships, but the cause of the variance is unknown at this time.

Future Work

There are several work streams needed in order to continue to test the concept of intensity as a function for human controllers to manage in light of automated separation assurance.

A human-in-the-loop simulation will provide great insight into how controllers will apply control to HIP and also if the control applied will solve the problems and lower the amount of HIP per minute as time goes on. This kind of dynamic simulation will provide more accurate insight into what HIP/minute, as well as what definition of HIP controllers feel is appropriate in a dynamic situation.

Next, evaluating the origin and cause of the high, non-constant variance in the number of HIP/minute will offer valuable insight into how intensity can be used in the future. It is of particular interest to analyze the data points where the number of aircraft in a sector (n) has very high variance in the number of HIP per minute. It may also provide assistance in managing increased air traffic levels, independent of the intensity measure.

Additionally, it will be necessary to evaluate if the "30 seconds or less" portion of the intensity definition is an appropriate measure. It is possible that more or less time may be needed to provide controllers with manageable workload. Another facet of this work would be to analyze the characteristics of aircraft traffic at current, 1.5x and 2x where 18 HIP per minute or less occur. These characteristics may also offer important insight into defining intensity more rigorously and may implicate other portions of NextGen such as sector design.

REFERENCES

REFERENCES

Administration, F. A. (2007). Fact Sheet - NextGen. Retrieved June 1, 2014, 2014, from http://www.faa.gov/news/fact_sheets/news_story.cfm?newsid=8145.

Belle, A., Shortle, J., Yousefi, A., & Xie, R. (2012). *Estimation of potential conflict rates as a function of sector loading.* Paper presented at the 5th International Conference on Research in Air Transportation, Berkeley, CA.

Burke, K. A., Wing, D. J., & Lewis, T. (2013). Pilot Subjective Assessments During an Investigation of Separation Function Allocation Using a Human-In-The-Loop Simulation.

Chen, Q., & Norcio, A. F. (1997). Modeling a user's domain knowledge with neural networks. *International Journal of Human-Computer Interaction, 9*(1), 25-40.

Embrey, D., Blackett, C., Marsden, P., & Peachey, J. (2006). Development of a human cognitive workload assessment tool. *Dalton (UK): Human Reliability Associates*.

Erzberger, H. (1995). Design principles and algorithms for automated air traffic management. *Knowledge-Based Functions in Aerospace Systems, 7*, 2.

Erzberger, H. (2001). *The automated airspace concept.* Paper presented at the 4th USA/Europe Air Traffic Management R&D Seminar.

Erzberger, H. (2004). *Transforming the NAS: The next generation air traffic control system.* Paper presented at the 24th International Congress of the Aeronautical Sciences, Yokohama, Japan.

Erzberger, H. (2009). *Separation assurance in the future air traffic system.* Paper presented at the Proceedings of the ENRI International Workshop on ATM/CNS.

Erzberger, H., Lauderdale, T., & Chu, Y. (2010). *Automated conflict resolution, arrival management and weather avoidance for ATM.* Paper presented at the 27th International Congress of the Aeronautical Sciences, Nice, France.

Erzberger, H., & Paielli, R. A. (2002). Concept for next generation air traffic control system. *Air Traffic Control Quarterly, 10*(4), 355-378.

Harrison, J. (2013). Human Factors Evaluation of Conflict Resolution Advisories in the En Route Domain.

Landry, S. J. (2012). *Intensity Control: A Concept for Automated Separation Assurance Safety and Function Allocation in NextGen*. Paper presented at the AIAA ATIO Conference, Indianapolish, Indiana, USA.

Landry, S. J. (2014). *System Modeling to Identify Agent Functions in Complex Human-Integrated Systems: An Application to Air Transportation*. Paper presented at the Applied Human Factors and Ergonomics AHFE 2014, Krakow, Poland.

Landry, S. J., & Lynam, A. (2011). Safe zone for closely spaced parallel approaches. *Journal of Guidance, Control, and Dynamics, 34*(2), 608-613.

Lauderdale, T., & Erzberger, H. (2014). Automated Separation Assurance with Weather and Uncertainty *Air Traffic Management and Systems* (pp. 35-47): Springer.

Li, R., & Zhou, Z. (2013). *Research on the operational condition evaluation of ATC automation system.* Paper presented at the Quality, Reliability, Risk, Maintenance, and Safety Engineering (QR2MSE), 2013 International Conference on.

Metzger, U., & Parasuraman, R. (2005). Automation in future air traffic management: Effects of decision aid reliability on controller performance and mental workload. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 47*(1), 35-49.

Morey, S., & Prevôt, T. (2013). Controller Strategies for Automation Tool Use under Varying Levels of Trajectory Prediction Uncertainty.

Parasuraman, R., & Riley, V. (1997). Humans and automation: Use, misuse, disuse, abuse. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 39*(2), 230-253.

Park, P., Khadilkar, H., Balakrishnan, H., & Tomlin, C. (2014). High Confidence Networked Control for Next Generation Air Transportation Systems. *IEEE Transactions on Automatic Control*.

Prevot, T., Homola, J., Mercer, J., Mainini, M., & Cabrall, C. (2009). *Initial evaluation of NextGen air/ground operations with ground-based automated separation assurance.* Paper presented at the Eighth USA/Europe Air Traffic Management Research and Development Seminar, Napa, CA.

Santiago, C. (2013). A Trajectory Management Strategy for Nonconforming Flights and Multi-Agent Separation Assurance.

Shortle, J., & Zhang, Y. (2014). Safety Comparison of Centralized and Distributed Aircraft Separation Assurance Concepts.

Snoddy, B. (2014). SOCAL TRACON Operations Interview. In C. Surakitbanharn (Ed.).

Spillane, J. (2014). In C. Surakitbanharn (Ed.).

Tomlin, C., Pappas, G. J., & Sastry, S. (1998). Conflict resolution for air traffic management: A study in multiagent hybrid systems. *Automatic Control, IEEE Transactions on, 43*(4), 509-521.

Wing, D., Prevot, T., Morey, S., Lewis, T., Martin, L., Johnson, S., . . . Sheth-Chandra, M. (2013). Pilot and controller evaluations of separation function allocation in air traffic management.

APPENDICES

Appendix A: Data and Results

A1: Raw Data (***Complete sets of all data are available upon request)

Data was taken from FlightSim in the following abbreviated format

```
// Track1
#Aircraft: "Airbus A321 Paint2"
#TailNumber: "F-MSAB"
#StaticCGtoGround:      9.2
#EngineType: Jet
#Data:  Timestamp        Latitude        Longitude    Altitude      Pitch
Mach
             2700    39.9764745432   -78.1018847157   33984.724    0.08111
0.8023300
             2701    39.9765543942   -78.1053695026   33998.800   -0.69297
0.8019029
             2702    39.9766229363   -78.1083805824   34011.919   -1.40412
0.8016706
             2703    39.9766923885   -78.1114423823   34018.622   -1.58154
0.8017347
             2704    39.9767601800   -78.1144345370   34012.189   -0.99024
```

From these 162 simulated aircraft flights, 72 were used for data runs. The data classes extracted from the large text files were Timestamp, Latitude, Longitude, Altitude, Heading, and Speed.

A2: Refined Data used for 1.0, 1.5, 2.0, and 3.0 analysis, after latitude/longitude manipulation

<u>1.0 Traffic Level</u>

Aircraft #	Time	velocity	heading	x	y	altitude
1	2520	847.2847122	274.71246	1428268.627	29794428.6	33440.23
3	2520	896.4350156	90.56609	1345156.369	30092741.76	30112.482
4	2520	848.5476803	270.75739	504995.4839	29770933.19	34732.193
7	2520	907.01205	269.1405	2552576.014	29118251.98	36005.999
22	2520	864.3984922	279.19739	3143534.475	30276579.42	33983.909
23	2520	871.6539452	276.85896	1995485.474	29461000.24	35980.477
24	2520	763.6584299	271.86522	1264563.254	29608561.11	30017.31

25	2520	731.978862	247.05557	2541561.783	29117000.14	25784.499
27	2520	758.5530755	98.0187	2523942.533	29627363.81	30999.138
28	2520	688.8391297	52.86184	1045630.976	29728741.83	26833.733
30	2520	831.0162471	78.7986	677879.7575	29354558.77	34981.284
1	2580	847.2975402	274.59242	1284909.603	30096348.15	33291.938
3	2580	896.802345	90.70765	567442.9859	29770409.09	29912.339
4	2580	848.172096	270.86198	2494105.04	29118849.81	34753.229
7	2580	902.2773714	269.19295	3079219.157	30275886.58	35986.885
22	2580	864.364693	279.08205	1936263.311	29468206.71	33985.75
23	2580	871.9070489	276.71522	1204653.563	29613922.59	35993.459
24	2580	763.4982462	271.80605	2488370.199	29118308.99	30018.882
25	2580	720.9125756	246.95468	2475251	29611826.23	24125.749
27	2580	757.5474652	98.13596	1098957.507	29723073.07	31020.351
28	2580	716.7019521	52.9429	717611.2107	29377386.72	28835.151
30	2580	830.1084649	78.91481	2057459.807	29893351.23	35022.634
1	2640	847.3460639	274.37756	1224648.974	30099856.24	33331.293
3	2640	897.236492	91.81162	629918.3233	29769670.18	29944.429
4	2640	847.7011376	271.23067	2436155.771	29119675.1	34330.229
7	2640	901.2352847	269.29386	3014680.879	30275268.79	35988.165
22	2640	864.037298	278.96965	1876449.015	29475390.83	33994.973
23	2640	871.2867274	284.77361	1144990	29620325.88	36014.509
24	2640	763.5751032	271.71099	2434723.631	29119570.4	30018.483
25	2640	685.9503566	246.86166	2427845.726	29596618.06	22118.919
27	2640	757.7124455	98.24379	1152274.261	29717324.37	30999.805
28	2640	745.9674976	53.01823	758697.1272	29400904.4	30836.742
30	2640	829.0397181	79.03079	2115010.267	29901680.25	34978.105
1	2700	850.3159327	280.78068	1164242.617	30106196.51	33214.88
3	2700	899.7809146	96.09387	692282.2416	29766169.92	29871.482
4	2700	847.2708944	271.48243	2378221.842	29120750.59	34990.112
7	2700	900.7438018	269.32495	2951223.501	30274716.65	36000.519
13	2700	856.5656639	105.4208	67118.72084	29757182.53	31000.456
22	2700	863.9149292	278.85449	1817138.139	29482421.1	33998.839
23	2700	878.5638208	304.98864	1090464.701	29640647.96	36079.418
24	2700	763.424178	271.60691	2381562.653	29120747.89	30018.948
25	2700	656.3490499	246.77707	2382565.227	29582020.21	20122.532

27	2700	758.6015991	98.34409	1205533.757	29711507.93	30982.254
28	2700	774.45845	53.09743	801350.7366	29425226.79	32847.13
30	2700	818.2160498	79.13984	2171960.996	29909833.66	35021.082
1	2760	851.4580784	283.63515	1105046.749	30115924.76	28993.43
3	2760	899.4671285	98.27813	754433.5578	29760090.91	34553.292
4	2760	847.0633024	271.54032	2320249.428	29121938.43	35982.192
7	2760	900.7230538	269.27358	2886650.514	30274142.91	35998.406
13	2760	860.2269107	105.53077	67118.72084	29744915.4	31000.159
22	2760	863.8139778	278.72143	1757806.317	29489351.39	34003.078
23	2760	876.7779283	314.61606	1044787.393	29670768.25	36077.435
24	2760	763.4152541	271.50387	2328350.611	29121852.21	30018.321
27	2760	758.4530164	98.43802	2338674.886	29567806.11	31004.196
28	2760	801.171876	53.17903	1258785.018	29705622.29	34846.809
30	2760	815.3290615	79.27173	845053.9073	29450049.78	34991.437
1	2820	848.5425337	284.17305	1046260.613	30126756.5	29112.394
3	2820	898.8859605	98.76401	816315.9503	29753055.97	35124.583
4	2820	847.0981056	271.4555	2262191.694	29123106.35	35774.128
7	2820	900.6166364	269.16761	2822645.159	30273505.58	36002.834
13	2820	862.772672	101.1424	67118.72084	29733094.31	31000.168
22	2820	863.7906641	278.68899	1698437.721	29496226.12	34007.834
23	2820	874.5509729	308.33838	999050.6375	29700735.42	36079.631
24	2820	763.3958446	271.40405	2275177.236	29122883.57	30017.1
27	2820	757.7111069	98.53352	1312506.036	29699614.31	31019.673
28	2820	827.8614307	53.26399	889947.9393	29475445.66	36844.82
30	2820	813.5045733	79.8611	2284761.831	29925516.43	34988.23
1	2880	848.3443119	283.70392	987497.2058	30137496.82	29421.291
3	2880	897.7019841	98.37935	878098.6442	29746070.47	34872.193
4	2880	847.1278891	271.29833	2203667.926	29124182.16	36001.283
7	2880	900.5276207	269.03585	2758619.668	30272768.42	36006.385
13	2880	865.8373571	93.76538	67118.72084	29728193.51	31000.54
22	2880	863.6690762	278.56496	1638518.041	29503096.59	34017.571
23	2880	874.8104348	303.78774	949478.2069	29727385.3	36063.818
24	2880	763.4217239	271.30378	2221811.348	29123847.37	30017.081
27	2880	757.6370387	98.63186	1365705.326	29693593.95	31005.192
28	2880	834.2277301	53.35694	936040.2498	29501408.27	38844.019

34	2880	692.7322859	78.16349	780293.6482	29628996.06	30812.689
1	2940	848.4921138	283.05893	928016.1294	30147870.57	29342.192
3	2940	897.4093922	97.89435	939981.1439	29739512.01	34982.183
4	2940	847.3301268	271.16512	2145655.322	29125119.69	35839.383
7	2940	900.6884737	268.89587	2694028.687	30271911.69	36002.193
13	2940	863.039273	92.97125	67118.72084	29725562.31	30980.181
22	2940	867.5867732	276.06002	1578870.151	29508767.84	34027.796
23	2940	873.7579742	304.16998	898600.951	29752616.07	35984.884
24	2940	763.4387908	271.18792	2168541.212	29124733.89	30016.692
27	2940	758.4617172	98.73357	1418861.977	29687507.29	30982.917
28	2940	825.627113	53.46799	981900.2981	29527116.89	40797.235
34	2940	715.3492027	317.24166	748862.9661	29654817.34	17999.997
1	3000	848.5040495	282.59974	868904.3451	868904.3451	29472.395
3	3000	898.4644185	97.81991	1001932.25	1001932.25	35001.282
4	3000	847.613795	271.09675	2087675.066	2087675.066	34899.383
7	3000	900.6401732	268.75682	2630032.704	2630032.704	36004.597
10	3000	832.7829532	277.56715	2762612.483	2762612.483	36049.804
13	3000	859.4410511	92.9662	67118.72084	67118.72084	31012.558
22	3000	864.8618649	274.72895	1518969.514	1518969.514	33980.531
23	3000	871.9827904	305.19156	848982.4518	848982.4518	36007.672
24	3000	763.4171504	271.14644	2115598.565	2115598.565	30013.801
27	3000	758.7324455	98.84064	1472017.978	1472017.978	30994.877
28	3000	890.0715049	53.46371	1029459.12	1029459.12	41005.978
1	3060	848.5642857	282.35285	809684.3326	30167333.96	29448.28
3	3060	898.138139	97.93257	1063845.613	29726732.22	34410.93
4	3060	847.8606521	270.99196	2029617.471	29126809.8	34996.453
7	3060	900.5967808	268.60544	2566028.337	30269868.48	36006.462
10	3060	833.3807419	277.35643	2705190.693	29112115.53	35997.694
13	3060	858.7152046	93.27849	67118.72084	29720721.28	30994.5
22	3060	864.5379279	274.28388	1459016.198	29516446.13	33985.453
23	3060	870.9681447	305.54129	799442.4601	29804668.91	36021.842
24	3060	763.4555231	271.05523	2062421.996	29126345.27	30013.138
27	3060	760.3111923	117.12282	1523742.549	29671104.01	31052.671
28	3060	936.0185798	53.57152	1080268.987	29582017.88	41002.208
1	3120	848.6760573	282.23748	749864.7717	30176895.46	29501.393

2	3120	861.9488859	89.71427	0	29771722.1	33459.193
3	3120	897.1924303	98.10239	1125715.088	29720202.63	35134.683
4	3120	848.0048846	270.87631	1971377.649	29127535.74	34953.193
7	3120	900.569786	268.2081	2502043.561	30268560.42	36007.535
10	3120	835.585053	273.03904	2648933.063	29115806.94	36068.272
13	3120	858.9941876	93.63356	67118.72084	29717874	30984.123
22	3120	864.0366287	274.2483	1398480.326	29519840.04	33999.023
23	3120	870.9713796	305.43727	749797.1839	29831079.33	36009.048
24	3120	763.5278066	270.9475	2008685.789	29127061.68	30017.528
27	3120	764.9963434	133.66676	1566770.697	29646568.23	31109.949
28	3120	949.6677732	54.82297	1132948.843	29611144.08	40999.737
1	3180	848.6578749	282.18214	690543.8181	30186305.14	29561.393
2	3180	862.0112415	89.76837	61297.96604	29771923.23	33362.153
3	3180	898.017555	98.27674	1187532.955	29713533.14	34996.692
4	3180	848.1555868	270.76222	1913204.467	29128171.19	34884.372
7	3180	900.7835131	267.89825	2437496.372	30266936.27	36000.962
10	3180	834.0422249	271.22564	2591839.207	29117252.43	35997.895
12	3180	874.2120883	289.81542	2897733.602	29852278.65	35990.429
13	3180	858.9753359	93.89728	67118.72084	29714774.13	30996.487
22	3180	863.8767796	274.3134	1338514.097	29523231.13	34007.128
23	3180	871.5992864	305.10825	700064.2581	29857275.88	35986.916
24	3180	763.5297029	270.84216	1955456.323	29127694.82	30017.875
27	3180	763.4619929	138.27954	1604032.295	29616658.5	31061.101
1	3240	848.6737148	282.14107	631192.6643	30195693.47	29648.482
2	3240	862.0295355	89.87832	122266.1584	29772063.86	335830.1
3	3240	898.6621941	98.42307	1249314.249	29706736.22	35003.282
4	3240	848.3472274	270.65391	1855353.219	29128717.32	34223.84
7	3240	900.8138543	267.70521	2373534.478	30265129.2	36000.603
10	3240	833.2091802	270.95334	2535290.897	29118011	36020.367
12	3240	873.8030398	289.68691	2838732.58	29868039.7	36011.359
13	3240	858.1334789	94.36799	67118.72084	29711530.54	31013.214
17	3240	801.0276437	358.80651	324825.3573	29408768.2	34100.02
22	3240	863.7859791	274.33976	1278554.015	29526660.78	34014.607
23	3240	873.3719046	299.90008	648512.4302	29881740.05	36089.123
24	3240	763.6017633	270.7422	1902223.284	29128255.02	30018.339

1	3300	847.2058473	277.67594	571663.3126	30204453.04	29454.383
2	3300	862.0406903	90.00327	183220.4601	29772108.07	33848.954
3	3300	897.810744	98.54468	1311145.801	29699821.55	35129.032
4	3300	848.4269846	270.5473	1797245.068	29129182.62	34580.4
7	3300	900.8738674	267.57364	2309564.434	30263194.4	35999.753
10	3300	834.0235962	271.2187	2478838.149	29118826.12	35978.6
12	3300	873.1498114	289.5678	2781035.192	29883336.68	36012.656
13	3300	862.66592	95.64421	67118.72084	29707379.38	31000.19
17	3300	803.1264299	358.79974	323655.5234	29451179.8	33681.309
22	3300	863.8418649	274.29758	1218563.131	29530082.03	34019.432
23	3300	874.9071474	296.39061	594348.5207	29902907.41	36049.153
24	3300	763.7023801	270.64564	1848861.827	29128746.71	30018.296
1	3360	852.7368711	264.85316	510316.6897	30204541.94	29876.77
2	3360	862.0470486	90.125	244424.9423	29772054.54	34002.228
3	3360	897.4114001	98.65704	1372905.676	29692815.54	35382.902
4	3360	848.4117025	270.43835	1738745.246	29129566.63	34430.32
7	3360	901.0253504	267.46485	2245040.527	30261146.3	35990.948
10	3360	832.6961684	271.46921	2422338.161	29119857.31	36010.955
12	3360	874.2647393	289.45168	2723263.249	29898545.22	35979.051
13	3360	863.6201064	95.86362	67118.72084	29702733.31	31000.044
17	3360	792.1105634	358.79676	322482.3508	29493485.77	31949.82
22	3360	864.410651	274.20143	1000575.077	29889176.8	34012.667
23	3360	872.7016093	295.36093	1158018.726	29533475.16	35981.351
1	3420	851.878728	259.6634	449984.9782	30197981.62	28763.118
2	3420	862.0519567	90.24914	305406.8022	29771900.07	34122.98
3	3420	898.3201862	98.77571	1434585.778	29685722.79	35763.983
4	3420	848.448402	270.3215	1680686.631	29129860.95	34883.28
7	3420	901.0605997	267.36042	2181103.225	30259030.98	35988.59
10	3420	833.5940227	271.56765	2365862.554	29121020.7	36008.73
12	3420	874.0468849	289.3438	2665448.941	29913661.14	36006.881
13	3420	863.8737678	95.92507	67118.72084	29697984.81	31000.012
17	3420	758.5852014	358.79392	321335.0498	29534694	29950.076
22	3420	864.8018518	274.08054	1046326.056	29882504.15	34002.571
23	3420	872.1395161	295.50005	1097994.71	29536750.79	36000.674
1	3480	849.061123	259.23113	390149.017	30189586.33	28845.98

2	3480	862.0809593	90.3056	366312.7812	29771687.38	33928.421
3	3480	898.7127256	98.71594	1496274.21	29678536.9	35485.119
4	3480	848.4757314	269.68185	1622632.773	29129920.96	35001.28
6	3480	878.1044638	97.6896	51889.67944	29800134.45	33802.941
7	3480	901.118828	267.2511	2117180.588	30256828.6	35986.21
10	3480	833.6741146	271.52031	2309387.906	29122195.24	35980.314
12	3480	873.1292865	289.23723	2607549.378	29928698.35	36017.33
13	3480	863.9514056	95.99793	67118.72084	29693198.55	31000.013
17	3480	727.2486453	358.82195	320238.888	29574507.7	27950.84
19	3480	654.2820551	101.17319	1093425.829	29875609.78	21281.586
22	3480	865.0159135	273.95038	1037967.742	29539926.23	33991.685
1	3540	848.3165363	260.73002	329811.3695	30181753.14	28764.22
2	3540	862.1009265	90.42566	427520.5106	29771393.91	34002.123
3	3540	897.9080143	97.19572	1558156.004	29672161.82	35185.403
4	3540	848.3386381	268.9062	1563069.44	29129316.1	35183.28
6	3540	877.4642866	97.82646	114085.1341	29793809.14	33890.2
7	3540	901.1338871	267.13623	2053268.664	30254534.77	35983.987
9	3540	663.6844832	1.36958	3025061.376	29945290.01	20339.392
10	3540	832.6168574	271.4032	2252909.096	29123300.66	36023.371
12	3540	874.095297	289.12355	2549498.245	29943672.82	35983.11
13	3540	863.9211759	96.09488	67118.72084	29688351.37	31000.007
17	3540	697.7169449	358.82456	319187.5192	29613070.1	25948.994
19	3540	679.4334666	101.26308	1141889.324	29868459.49	23281.581
1	3600	847.9430718	262.28227	269750.6542	30175315.1	29003.8
2	3600	862.0628885	90.54662	488458.4412	29771005.12	34113.39
3	3600	897.6261311	96.5413	1619609.052	29666687.42	35211.353
4	3600	848.4123718	268.50827	1505039.835	29128278.66	35099.375
6	3600	876.6671606	97.95565	175164.1058	29787485.92	33909.395
7	3600	900.9969055	267.01522	1988794.446	30252123.24	35980.665
10	3600	834.0936487	271.24993	3025822.87	29982656.36	35990.194
12	3600	874.3917931	289.00508	2196385.345	29124302.56	35995.799
13	3600	863.9547521	96.20947	2491424.322	29958546.85	31000.015
17	3600	669.5714584	358.82226	67118.72084	29683398.46	23949.375
19	3600	710.5590844	131.82357	318169.3204	29650332.16	25293.747
1	3660	847.7565626	262.38292	209606.3618	30169411.83	29046.764

2	3660	862.0856444	90.6678	549428.7334	29770519.78	34122.184
3	3660	898.4422204	96.50734	1681638.004	29661396.4	35231.988
4	3660	848.4674768	268.49942	1447022.263	29127119.28	35004.51
6	3660	877.205717	98.08121	235571.2097	29781128.99	34015.499
7	3660	900.9067742	266.89523	1924898.694	30249633.55	35981.909
10	3660	833.038734	271.16087	2139804.514	29125201.44	35999.134
12	3660	873.4585778	288.86222	2432767.088	29973449.49	36021.421
13	3660	866.8514451	113.89488	67118.72084	29674580.48	31002.573
17	3660	642.4359326	358.81969	317176.958	29686513.77	21943.647
19	3660	736.4143674	146.69554	1220424.902	29823180.72	27308.609
22	3660	864.1736103	273.83454	857166.8647	29549098.21	34000.254
1	3720	847.6280586	262.04557	149500.6074	30163378.19	29134.554
2	3720	862.0887677	90.79808	610575.0211	29769934.14	342004.382
3	3720	898.7913673	96.75672	1743558.842	29655995.66	35359.021
4	3720	848.506965	268.44415	1389039.966	29125928.05	35144.3
6	3720	876.0595556	98.20933	295927.3711	29774675.09	33993.012
7	3720	900.7744776	266.77508	1861029.962	30247046.1	35984.791
10	3720	833.6260372	271.08996	2082797.709	29126062.71	36009.895
12	3720	873.4904807	288.86543	2374497.601	29988196.06	36003.467
13	3720	865.6934595	127.79352	67118.72084	29649393.03	31001.451
19	3720	764.7163565	145.07384	316684.0061	29721409	29311.023
22	3720	863.9720421	273.7363	1250957.752	29789847.61	34012.769
1	3780	847.7561164	261.74866	88873.03349	30157017.09	29259.448
2	3780	862.2369042	96.36446	671321.5645	29766890.99	34120.375
3	3780	898.049681	97.05021	1805452.384	29650358.5	35238.5
4	3780	848.4166106	268.47477	1330557.167	29124730.31	35062.421
6	3780	878.1303431	92.99792	356610.3347	29770292.99	34108.996
7	3780	900.6163018	266.654	1797163.024	30244359.46	35989.631
10	3780	833.6834847	270.98337	2026333.713	29126845.72	35981.158
12	3780	874.4693193	288.77134	2316266.497	30002879.8	35979.219
13	3780	864.8818321	120.81885	67118.72084	29621318.59	30999.517
19	3780	794.4507406	144.72356	345488.9199	29746035.97	31312.82
22	3780	864.287613	273.60643	1283015.469	29755847.18	34017.541
1	3840	848.5458802	261.55734	27793.37747	30150418.66	29841.599

2	3840	862.1171011	97.75044	731975.3146	29761074.09	34118.304
3	3840	897.5103437	97.31479	1867302.531	29644491.35	35422.429
6	3840	879.5231384	89.86891	417744.1612	29769465.16	34258.281
7	3840	900.2659278	266.53194	1732743.028	30241548.12	36002.917
10	3840	832.7620936	270.87418	1969811.898	29127545.81	36024.497
12	3840	874.1659072	288.62645	2257929.499	30017476.75	36007.539
13	3840	865.0835119	109.02704	67118.72084	29603423.13	31001.239
19	3840	838.9926384	144.69048	1316149.813	29720845.85	32932.319
22	3840	864.8047521	273.47397	676329.719	29557820.8	34005.847
23	3840	872.1697458	295.65023	97085.6632	30081442.53	35998.99
24	3840	764.6291255	267.81203	1369479.032	29125391.1	29984.251
2	3900	862.0898832	97.83197	792269.4159	29754879.52	34211.48
3	3900	898.0685327	97.34048	1929127.23	29638509.87	35332.651
6	3900	877.7211829	89.19283	479062.3665	29769983.23	34129.831
7	3900	900.1365314	266.40827	1668903.148	30238660.41	36009.865
10	3900	834.2198102	270.76025	1913323.542	29128161.17	35984.552
12	3900	873.0996146	285.13849	2199320.927	30031418.07	36056.828
13	3900	864.2243649	107.92616	67118.72084	29589041.19	30999.979
16	3900	690.7859867	270.5454	2664063.748	29237991.08	30001.77
19	3900	844.4759194	144.73464	1350611.164	29684365.52	33000.566
22	3900	865.1351589	273.34905	616182.3565	29560518.95	33990.891
24	3900	764.3595126	267.04761	1316239.085	29123505.16	29989.318
27	3900	758.7031083	115.72102	2111864.841	29332197.47	30983.109
2	3960	862.07092	97.7892	852879.3562	29748668.51	34298.571
3	3960	898.7975025	97.40759	1990885.692	29632507.33	35281.048
6	3960	882.6160453	89.73822	540504.2891	29770438.53	34082.388
7	3960	900.0614592	266.27984	1604859.176	30235659.16	36017.855
10	3960	832.8947248	270.65738	1856790.835	29128695.14	36007.845
12	3960	877.2842472	277.79902	2138661.984	30039931.99	36052.306
13	3960	864.0232429	108.50065	67118.72084	29574665.55	31000.012
16	3960	702.691676	270.4754	2612855.299	29238337.52	30005.76
19	3960	845.5318381	144.79425	1384876.819	29647963.01	33000.046
20	3960	880.609956	268.17539	3158855.921	30278223	35980.511
22	3960	865.0659988	273.23191	556022.9417	29563122.54	33981.829
27	3960	758.9516385	116.07253	2159535.164	29314550.38	30988.867

2	4020	862.0760512	97.81058	913178.3711	29742490.97	33992.755
3	4020	898.7562295	97.51745	2052623.108	29626428.77	35209.384
6	4020	885.9699759	90.66914	603189.4881	29770257.01	34116.996
7	4020	900.2265511	266.13001	1540949.063	30232551.2	36020.168
10	4020	833.9687144	270.55333	1800022.677	29129152.8	36002.205
12	4020	877.1136895	274.96498	2076880.163	30044739.3	36030.592
13	4020	864.0046143	108.99756	67118.72084	29559775.66	31000.026
14	4020	865.3863663	279.01065	2716768.622	29110339.46	36010.158
16	4020	710.803822	270.39358	2563370.899	29238623.46	30020.281
19	4020	845.7977698	144.85635	1419211.081	29611348.11	33000.006
20	4020	880.4045951	268.29805	3095625.307	30276744.92	35988.957
22	4020	864.41634	273.11737	495294.1993	29565657.59	33995.989
2	4080	862.0801785	97.89283	973452.8849	29736276.34	34048.429
3	4080	897.7702518	97.64032	2113813.722	29620303.72	35199.424
6	4080	890.0387096	94.70957	664971.4798	29768257.61	34321.493
7	4080	900.6055931	267.89442	1476997.58	30230186.6	36015.537
10	4080	862.006668	270.45259	1742511.055	29129536.78	36017.501
12	4080	874.9247721	274.43002	2015082.353	30048367.86	35978.111
13	4080	863.9487284	109.26457	67118.72084	29544711.43	31000.001
14	4080	867.4291551	274.22577	2658386.432	29115592.59	36053.634
16	4080	722.0532711	270.34625	2512197.919	29238873.16	29996.594
19	4080	845.8657029	144.91634	1453300.063	29574855.97	32999.999
20	4080	879.1233483	268.78933	3033002.693	30275596.43	36022.412
22	4080	864.074109	272.99463	435106.5107	29568074.82	34011.984
2	4140	862.0927835	98.01127	1033950.546	29729950.8	34194.322
3	4140	897.7256324	97.76863	2175485.339	29614023.89	35224.59
6	4140	892.1978435	97.73403	726535.312	29763020.46	34199.999
7	4140	900.9800616	268.84992	1413056.884	30228961.87	36006.568
10	4140	873.5493783	270.33617	1683523.09	29129847.3	35981.766
12	4140	874.5919112	274.78549	1953553.267	30052013.2	36001.373
13	4140	863.9689187	111.88897	67118.72084	29529151.87	30999.966
14	4140	868.6595357	271.46601	2599659.763	29117601.38	36012.798
16	4140	734.2328122	270.26419	2460981.985	29239081.69	30012.214
19	4140	845.8741806	146.31218	1487223.049	29538318.86	32998.701
20	4140	879.1738798	269.17214	2970337.556	30274812.41	36000.319

22	4140	864.2651917	272.55188	374882.2708	29570285.68	34018.589
2	4200	862.0769436	98.12897	1094149.112	29723559.55	34138.129
3	4200	898.348408	97.89585	2237180.112	29607635.96	35179.493
6	4200	888.8663342	98.72337	788111.4158	29756231.99	35996.209
7	4200	901.2894973	268.98332	1349066.753	30228124.31	35995.719
10	4200	876.5319637	269.7269	1624162.562	29129935.06	35996.975
12	4200	873.4727445	275.22449	1892127.073	30056007.38	36022.66
13	4200	867.0854739	118.99452	67118.72084	29508689.72	30884.019
14	4200	865.7732167	270.75992	2540430.909	29118375.14	36006.202
16	4200	735.9166377	270.15022	2409416.222	29239222.15	30003.329
19	4200	847.0124221	163.49236	1509543.341	29497087.13	33001.692
20	4200	880.1848444	269.30982	2907693.306	30274225.85	35980.224
22	4200	864.9440762	272.06857	314651.0951	29572084.81	34006.009
2	4260	862.0777244	98.2424	1154355.889	29717073.07	33721.308
3	4260	898.9372729	98.02535	2298808.316	29601149.89	35482.348
6	4260	889.0880928	98.56526	849280.7106	29749231.18	35400.954
7	4260	901.3307703	268.64596	1284536.204	30227159.51	35981.807
10	4260	876.5389913	268.94958	1564685.024	29129360.88	36018.851
11	4260	835.3178942	44.33983	879401.8913	29354612.49	27667.036
12	4260	873.7213862	275.48742	1830641.687	30060286.36	36000.713
13	4260	863.3163596	119.29274	67118.72084	29485916.98	29820.643
14	4260	864.7417271	270.94267	2481764.489	29119023.03	36010.938
16	4260	737.5878582	270.54328	2357740.071	29239373.44	29988.699
19	4260	846.1789313	165.63875	1524830.283	29453802.29	32999.985
20	4260	879.5895098	269.26512	2845098.131	30273664.13	36012.785
2	4320	862.0886562	98.35411	1214556.277	29710495.11	33689.385
3	4320	898.9210983	98.11744	2360610.187	29594540.48	35508.498
6	4320	889.3957437	97.98221	910611.656	29742580.21	35411.554
7	4320	901.0833556	268.2577	1220623.484	30225856.4	35982.886
10	4320	876.3512551	268.48526	1505253.399	29128302.46	36016.28
11	4320	807.2739169	44.44632	921487.8189	29387272.91	25614.173
12	4320	874.5901264	275.54056	1769188.935	30064675.88	35979.419
13	4320	785.6176564	118.95403	67118.72084	29464346.53	27639.44
14	4320	865.9138794	271.30022	2423105.185	29119917.98	35979.408
16	4320	736.4772808	271.10044	2306080.793	29239983.94	30020.701

19	4320	845.9643118	165.46189	1539477.874	29410608.29	33000.001
20	4320	878.9169835	269.13213	2782460.615	30273021.86	36015.175
2	4380	862.0753819	98.46503	1274942.533	29703805.44	33650.851
3	4380	898.3284408	98.19407	2422135.065	29587904.67	35574.118
6	4380	888.2115442	97.80969	971960.4779	29736242.35	35328.849
7	4380	900.7424632	268.05636	1156714.793	30224338.7	35992.127
10	4380	876.8959467	268.48368	1445822.049	29127098.14	35993.982
11	4380	776.6746968	44.62488	961496.7887	29418117.79	23607.8
12	4380	874.5836566	275.46397	1707738.218	30069045.3	35998.277
13	4380	736.444374	128.95525	67118.72084	29443329.52	25434.732
14	4380	865.0955592	271.50007	2364427.638	29121036.31	36018.13
16	4380	737.3192493	271.21755	2254428.168	29240805.91	29984.168
19	4380	845.9048565	165.1951	1554435.282	29367295.21	33000.032
20	4380	879.6200741	268.96856	2719264.762	30272251.02	35988.612
2	4440	862.0776129	98.57552	1335079.867	29697052.48	33601.338
3	4440	897.7435917	98.33585	2483618.376	29581176.69	35548.539
6	4440	889.5136505	97.87653	1033092.318	29729950.92	35285.309
7	4440	900.4131719	267.90956	1092827.857	30222681.81	36004.821
10	4440	877.5804087	268.19374	1386339.69	29125845.02	35979.842
11	4440	746.4615462	44.85358	1000787.735	29448154.44	21610.311
12	4440	873.8986369	275.33332	1645728.807	30073363.62	36017.955
13	4440	701.9544516	140.44139	67118.72084	29414700.03	23240.261
14	4440	864.9521077	271.52245	2305764.296	29122235.65	36001.008
16	4440	737.4294593	271.10929	2202704.079	29241612.04	30006.817
19	4440	845.8971596	165.07549	1569486.517	29324211.33	33000.03
2	4500	862.0814055	98.687	1395210.332	29690209.01	33458.499
3	4500	897.9304356	98.46588	2545105.51	29574334.5	35428.759
6	4500	888.6778172	98.02981	1094386.768	29723539.84	35221.83
7	4500	900.3141167	267.79001	1028358.11	30220901.74	36019.524
10	4500	877.7724953	267.2651	1326747.421	29123975.16	35989.521
12	4500	873.498066	275.19198	1038870.807	29476999.12	36015.621
13	4500	670.1932301	141.58267	1584144.918	30077539.41	21033.095
14	4500	865.9873899	271.41509	67118.72084	29385021.38	35981.45
16	4500	737.8845774	270.94955	2246782.75	29123399.83	30012.133
19	4500	845.8887935	165.04688	2150815.542	29242319.19	33000.017

20	4500	879.3851528	268.67446	1584640.661	29280959.09	36018.893
2	4560	862.0891024	98.80153	1455254.22	29683282.79	33388.553
3	4560	898.4855012	98.57087	2606535.161	29567376.66	35403.84
6	4560	888.7730796	98.2013	1155421.716	29717016.97	35117.468
7	4560	900.7459212	267.67815	964446.8121	30219043.69	36014.956
12	4560	874.0990897	275.05393	1076039.411	29505062.68	35991.04
14	4560	865.0619831	271.25172	1522520.974	30081605.75	36019.746
16	4560	746.2704635	270.80658	67118.72084	29356438.93	29984.236
19	4560	845.9070874	165.05622	2188140.15	29124445.9	33000.011
20	4560	879.0583155	268.39444	2098734.405	29242923.41	36011.021
26	4560	688.3823383	335.12536	1599708.625	29237893.81	23995.756

1.5x Traffic Level

Aircraft #	Time	velocity	heading	x	y	altitude
1	2520	847.2847122	274.71246	1345156.271	29860422.15	33440.23
3	2520	896.4350156	90.56609	504995.3861	29538613.58	30112.482
4	2520	848.5476803	270.75739	2552575.916	28885932.37	34732.193
7	2520	907.01205	269.1405	3143534.378	30044259.81	36005.999
22	2520	864.3984922	279.19739	1995485.376	29228680.63	33983.909
23	2520	871.6539452	276.85896	1264563.156	29376241.5	35980.477
24	2520	763.6584299	271.86522	2541561.685	28884680.53	30017.31
25	2520	731.978862	247.05557	2523942.436	29395044.2	25784.499
27	2520	758.5530755	98.0187	1045630.878	29496422.22	30999.138
28	2520	688.8391297	52.86184	677879.6597	29122239.16	26833.733
30	2520	831.0162471	78.7986	2000124.812	29652642.2	34981.284
34	2520	566.3216651	78.26759	1468652.457	29570281.79	20000.231
1	2580	847.2975402	274.59242	1284909.506	29864028.54	33291.938
3	2580	896.802345	90.70765	567442.8881	29538089.48	29912.339
4	2580	848.172096	270.86198	2494104.943	28886530.2	34753.229
7	2580	902.2773714	269.19295	3079219.059	30043566.97	33331.293
22	2580	864.364693	279.08205	1936263.214	29235887.1	29944.429
23	2580	871.9070489	276.71522	1204653.465	29381602.98	34330.229
24	2580	763.4982462	271.80605	2488370.102	28885989.38	33214.88

25	2580	720.9125756	246.95468	2475250.902	29379506.62	29871.482
27	2580	757.5474652	98.13596	1098957.41	29490753.46	34990.112
28	2580	716.7019521	52.9429	717611.1129	29145067.11	28993.43
30	2580	830.1084649	78.91481	2057459.709	29661031.62	34553.292
34	2580	585.547171	78.08092	1510594.027	29576791.2	35982.192
1	2640	847.3460639	274.37756	1224648.876	29867536.63	33331.293
3	2640	897.236492	91.81162	629918.2255	29537350.57	29944.429
4	2640	847.7011376	271.23067	2436155.673	28887355.49	34330.229
7	2640	901.2352847	269.29386	3014680.781	30042949.18	29421.291
22	2640	864.037298	278.96965	1876448.917	29243071.22	34872.193
23	2640	871.2867274	284.77361	1144989.902	29388006.27	36001.283
24	2640	763.5751032	271.71099	2434723.534	28887250.79	29342.192
25	2640	685.9503566	246.86166	2427845.628	29364298.45	34982.183
27	2640	757.7124455	98.24379	1152274.163	29485004.76	35839.383
28	2640	745.9674976	53.01823	758697.0293	29168584.79	29472.395
30	2640	829.0397181	79.03079	2115010.169	29669360.64	35001.282
34	2640	606.564816	77.86117	1553733.639	29583664.76	34899.383
1	2700	850.3159327	280.78068	1164242.52	29873876.9	33214.88
3	2700	899.7809146	96.09387	692282.1438	29533850.31	29871.482
4	2700	847.2708944	271.48243	2378221.744	28888430.98	34990.112
7	2700	900.7438018	269.32495	2951223.403	30042397.04	36000.519
13	2700	856.5656639	105.4208	67118.62302	29524862.92	31000.456
22	2700	863.9149292	278.85449	1817138.041	29250101.49	33998.839
23	2700	878.5638208	304.98864	1090464.603	29408328.35	36079.418
24	2700	763.424178	271.60691	2381562.555	28888428.28	30018.948
25	2700	656.3490499	246.77707	2382565.129	29349700.6	20122.532
27	2700	758.6015991	98.34409	1205533.659	29479188.32	30982.254
28	2700	774.45845	53.09743	801350.6388	29192907.18	32847.13
30	2700	818.2160498	79.13984	2171960.898	29677514.05	35021.082
34	2700	628.3781369	77.88136	1597997.466	29590763.39	25404.924
1	2760	851.4580784	283.63515	1105046.651	29883605.15	28993.43
3	2760	899.4671285	98.27813	754433.46	29527771.3	34553.292
4	2760	847.0633024	271.54032	2320249.33	28889618.82	35982.192
7	2760	900.7230538	269.27358	2886650.417	30041823.3	35998.406
13	2760	860.2269107	105.53077	67118.62302	29512595.79	31000.159

22	2760	863.8139778	278.72143	1757806.219	29257031.78	34003.078
23	2760	876.7779283	314.61606	1044787.295	29438448.64	36077.435
24	2760	763.4152541	271.50387	2328350.514	28889532.6	30018.321
27	2760	758.4530164	98.43802	1258784.92	29473302.68	31004.196
28	2760	801.171876	53.17903	845053.8094	29217730.17	34846.809
30	2760	815.3290615	79.27173	2228409.12	29685503.28	34991.437
34	2760	650.966051	77.9618	1643732.585	29598058.23	27212.03
35	2760	784.1104122	70.01168	1774664.132	29562543.93	35001.56
38	2760	615.1904199	18.97606	1044021.457	29161589.62	24268.342
1	2820	848.5425337	284.17305	1046260.516	29894436.89	29112.394
3	2820	898.8859605	98.76401	816315.8525	29520736.36	35124.583
4	2820	847.0981056	271.4555	2262191.596	28890786.74	35774.128
7	2820	900.6166364	269.16761	2822645.061	30041185.97	36002.834
13	2820	862.772672	101.1424	67118.62302	29500774.7	31000.168
22	2820	863.7906641	278.68899	1698437.624	29263906.51	34007.834
23	2820	874.5509729	308.33838	999050.5397	29468415.81	36079.631
24	2820	763.3958446	271.40405	2275177.139	28890563.96	30017.1
27	2820	757.7111069	98.53352	1312505.938	29467294.7	31019.673
28	2820	827.8614307	53.26399	889947.8414	29243126.05	36844.82
30	2820	813.5045733	79.8611	2284761.733	29693196.82	34988.23
34	2820	672.2597787	78.06549	1690570.435	29605465.3	29012.582
35	2820	783.8877613	70.1083	1826381.384	29576540.42	35024.676
38	2820	640.1294431	19.00199	1058752.952	29194058.64	26278.699
1	2880	848.3443119	283.70392	987497.108	29905177.21	29421.291
3	2880	897.7019841	98.37935	878098.5464	29513750.86	34872.193
4	2880	847.1278891	271.29833	2203667.828	28891862.55	36001.283
7	2880	900.5276207	269.03585	2758619.57	30040448.82	36006.385
13	2880	865.8373571	93.76538	67118.62302	29495873.9	31000.54
22	2880	863.6690762	278.56496	1638517.943	29270776.98	34017.571
23	2880	874.8104348	303.78774	949478.1091	29495065.69	36063.818
24	2880	763.4217239	271.30378	2221811.25	28891527.77	30017.081
27	2880	757.6370387	98.63186	1365705.228	29461274.34	31005.192
28	2880	834.2277301	53.35694	936040.152	29269088.66	38844.019
34	2880	692.7322859	78.16349	1738526.695	29612981.35	30812.689
35	2880	785.1750317	70.22591	1878579.907	29590574.33	35000.891

38	2880	666.2127313	19.02971	1073921.008	29227393.45	28278.996
1	2940	848.4921138	283.05893	928016.0315	29915550.96	29342.192
3	2940	897.4093922	97.89435	939981.0461	29507192.4	34982.183
4	2940	847.3301268	271.16512	2145655.224	28892800.08	35839.383
7	2940	900.6884737	268.89587	2694028.589	30039592.08	36002.193
13	2940	863.039273	92.97125	67118.62302	29493242.7	30980.181
22	2940	867.5867732	276.06002	1578870.053	29276448.23	34027.796
23	2940	873.7579742	304.16998	898600.8532	29520296.46	35984.884
24	2940	763.4387908	271.18792	2168541.114	28892414.28	30016.692
27	2940	758.4617172	98.73357	1418861.879	29455187.68	30982.917
28	2940	825.627113	53.46799	981900.2002	29294797.28	40797.235
34	2940	715.3492027	78.26444	1787682.067	29620617.38	32612.263
35	2940	785.234264	70.33688	1930395.529	29604410.94	34977.763
38	2940	693.4217676	19.0591	1089642.909	29261841.22	30283.288
1	3000	848.5040495	282.59974	868904.2473	29925411.56	29472.395
3	3000	898.4644185	97.81991	1001932.152	29500818.28	35001.282
4	3000	847.613795	271.09675	2087674.969	28893679.62	34899.383
7	3000	900.6401732	268.75682	2630032.607	30038629.24	36004.597
10	3000	832.7829532	277.56715	2762612.385	28873493.73	36049.804
13	3000	859.4410511	92.9662	67118.62302	29490897.72	31012.558
22	3000	864.8618649	274.72895	1518969.416	29280611.91	33980.531
23	3000	871.9827904	305.19156	848982.354	29546041.42	36007.672
24	3000	763.4171504	271.14644	2115598.467	28893243.58	30013.801
27	3000	758.7324455	98.84064	1472017.88	29449025.94	30994.877
28	3000	890.0715049	53.46371	1029459.022	29321384.78	41005.978
34	3000	721.9214207	78.44056	1837761.961	29628304.9	34410.93
35	3000	784.3158847	70.43666	1982319.653	29618188.15	34996.453
38	3000	721.4663026	19.09018	1105895.048	29297338.17	32285.329
1	3060	848.5642857	282.35285	809684.2348	29935014.35	29448.28
3	3060	898.138139	97.93257	1063845.515	29494412.61	34410.93
4	3060	847.8606521	270.99196	2029617.374	28894490.19	34996.453
7	3060	900.5967808	268.60544	2566028.24	30037548.87	36006.462
10	3060	833.3807419	277.35643	2705190.595	28879795.92	35997.694
13	3060	858.7152046	93.27849	67118.62302	29488401.67	30994.5
22	3060	864.5379279	274.28388	1459016.1	29284126.52	33985.453

23	3060	870.9681447	305.54129	799442.3622	29572349.3	36021.842
24	3060	763.4555231	271.05523	2062421.898	28894025.66	30013.138
27	3060	760.3111923	117.12282	1523742.451	29438784.4	31052.671
28	3060	936.0185798	53.57152	1080268.89	29349698.27	41002.208
34	3060	769.5118291	78.54627	1888957.385	29636055.09	35027.593
35	3060	783.9058322	70.5327	2034311.029	29631899.54	35023.509
38	3060	747.7083245	19.12476	1122677.723	29333871.73	34285.709
1	3120	848.6760573	282.23748	749864.6739	29944575.85	29501.393
2	3120	861.9488859	89.71427	0	29539402.49	33459.193
3	3120	897.1924303	98.10239	1125714.99	29487883.02	35134.683
4	3120	848.0048846	270.87631	1971377.551	28895216.13	34953.193
7	3120	900.569786	268.2081	2502043.463	30036240.81	36007.535
10	3120	835.585053	273.03904	2648932.965	28883487.33	36068.272
13	3120	858.9941876	93.63356	67118.62302	29485554.39	30984.123
22	3120	864.0366287	274.2483	1398480.228	29287520.43	33999.023
23	3120	870.9713796	305.43727	749797.086	29598759.72	36009.048
24	3120	763.5278066	270.9475	2008685.691	28894742.07	30017.528
27	3120	764.9963434	133.66676	1566770.599	29414248.62	31109.949
28	3120	949.6677732	54.82297	1132948.745	29378824.47	40999.737
34	3120	773.1237715	78.66421	1942711.412	29644112.04	34994.617
35	3120	785.057348	70.63219	2086463.511	29645571.04	35006.737
38	3120	793.0551566	19.82063	1140435.43	29372343.62	35002.444
1	3180	848.6578749	282.18214	690543.7203	29953985.53	29561.393
2	3180	862.0112415	89.76837	61297.86822	29539603.62	33362.153
3	3180	898.017555	98.27674	1187532.857	29481213.53	34996.692
4	3180	848.1555868	270.76222	1913204.369	28895851.58	34884.372
7	3180	900.7835131	267.89825	2437496.274	30034616.66	36000.962
10	3180	834.0422249	271.22564	2591839.109	28884932.82	35997.895
12	3180	874.2120883	289.81542	2897733.504	29619959.04	35990.429
13	3180	858.9753359	93.89728	67118.62302	29482454.53	30996.487
22	3180	863.8767796	274.3134	1338513.999	29290911.52	34007.128
23	3180	871.5992864	305.10825	700064.1603	29624956.27	35986.916
24	3180	763.5297029	270.84216	1955456.225	28895375.21	30017.875
27	3180	763.4619929	138.27954	1604032.198	29384338.89	31061.101
28	3180	920.4262106	67.95161	1191025.847	29400752.22	40998.61

30	3180	809.9906821	80.78351	2623900.087	29735349.1	35000.27
34	3180	793.6564033	78.78609	1998061.225	29652312.23	35036.512
1	3240	848.6737148	282.14107	631192.5665	29963373.86	29648.482
2	3240	862.0295355	89.87832	122266.0606	29539744.25	33583.1
3	3240	898.6621941	98.42307	1249314.151	29474416.61	35003.282
4	3240	848.3472274	270.65391	1855353.121	28896397.71	34223.84
7	3240	900.8138543	267.70521	2373534.38	30032809.59	36000.603
10	3240	833.2091802	270.95334	2535290.799	28885691.39	36020.367
12	3240	873.8030398	289.68691	2838732.482	29635720.09	36011.359
13	3240	858.1334789	94.36799	67118.62302	29479210.93	31013.214
17	3240	801.0276437	358.80651	324825.2594	29176448.59	34100.02
22	3240	863.7859791	274.33976	1278553.918	29294341.17	34014.607
23	3240	873.3719046	299.90008	648512.3324	29649420.44	36089.123
24	3240	763.6017633	270.7422	1902223.186	28895935.41	30018.339
27	3240	758.5448209	137.40709	1640000.128	29354236.86	30987.31
28	3240	892.592837	69.85609	1249822.854	29417457.39	40998.373
30	3240	810.2379852	80.88396	2680497.116	29742109.75	35019.623
32	3240	677.0513471	121.19575	1466202.052	29309545.69	26227.102
1	3300	847.2058473	277.67594	571663.2148	29972133.43	29454.383
2	3300	862.0406903	90.00327	183220.3623	29539788.46	33848.954
3	3300	897.810744	98.54468	1311145.703	29467501.94	35129.032
4	3300	848.4269846	270.5473	1797244.971	28896863.01	34580.4
7	3300	900.8738674	267.57364	2309564.336	30030874.79	35999.753
10	3300	834.0235962	271.2187	2478838.051	28886506.51	35978.6
12	3300	873.1498114	289.5678	2781035.094	29651017.07	36012.656
13	3300	862.66592	95.64421	67118.62302	29475059.77	31000.19
17	3300	803.1264299	358.79974	323655.4256	29218860.19	33681.309
22	3300	863.8418649	274.29758	1218563.033	29297762.42	34019.432
23	3300	874.9071474	296.39061	594348.4228	29670587.8	36049.153
24	3300	763.7023801	270.64564	1848861.73	28896427.1	30018.296
27	3300	758.9993812	135.43983	1676953.3	29325053.59	30984.577
28	3300	881.4853891	69.76319	1307580.557	29433365.36	40999.42
30	3300	811.1138645	80.99406	2737007.274	29748779.96	34979.338
32	3300	756.5079442	154.3281	1500638.83	29283838.94	28996.901
1	3360	852.7368711	264.85316	510316.5919	29972222.33	29876.77

2	3360	862.0470486	90.125	244424.8445	29539734.93	34002.228
3	3360	897.4114001	98.65704	1372905.578	29460495.93	35382.902
4	3360	848.4117025	270.43835	1738745.148	28897247.02	34430.32
7	3360	901.0253504	267.46485	2245040.429	30028826.69	35990.948
10	3360	832.6961684	271.46921	2422338.063	28887537.7	36010.955
12	3360	874.2647393	289.45168	2723263.151	29666225.61	35979.051
13	3360	863.6201064	95.86362	67118.62302	29470413.7	31000.044
17	3360	792.1105634	358.79676	322482.253	29261166.16	31949.82
22	3360	864.410651	274.20143	1158018.628	29301155.55	34012.667
23	3360	872.7016093	295.36093	538818.9566	29690430.54	35981.351
24	3360	763.8306609	270.55063	1795625.619	28896849.66	30017.538
27	3360	758.6132001	134.18445	1714971.359	29296680.46	31004.469
28	3360	873.541793	69.61061	1364606.54	29449212.61	41009.692
30	3360	809.8493501	81.09874	2793504.402	29755366.09	35007.622
32	3360	799.9652553	165.37127	1517979.522	29243495.09	29002.172
1	3420	851.878728	259.6634	449984.8804	29965662.01	28763.118
2	3420	862.0519567	90.24914	305406.7043	29539580.46	34122.98
3	3420	898.3201862	98.77571	1434585.68	29453403.18	35763.983
4	3420	848.448402	270.3215	1680686.533	28897541.34	34883.28
7	3420	901.0605997	267.36042	2181103.127	30026711.37	35988.59
10	3420	833.5940227	271.56765	2365862.456	28888701.09	36008.73
12	3420	874.0468849	289.3438	2665448.843	29681341.53	36006.881
13	3420	863.8737678	95.92507	67118.62302	29465665.2	31000.012
17	3420	758.5852014	358.79392	321334.9519	29302374.39	29950.076
22	3420	864.8018518	274.08054	1097994.612	29304431.18	34002.571
23	3420	872.1395161	295.50005	483534.8446	29709890.2	36000.674
24	3420	763.9625113	270.4538	1742399.122	28897203.97	30015.936
27	3420	757.7996765	133.77598	1753457.682	29268708.8	31019.762
28	3420	871.1008875	69.52264	1422815.977	29465477.34	41004.486
30	3420	810.572854	81.20664	2850107.672	29761882.84	35013.43
31	3420	760.6412645	209.69426	1134310.326	29143036.69	26744.393
32	3420	808.1120928	165.93937	1531904.065	29201500.46	29000.386
1	3480	849.061123	259.23113	390148.9192	29957266.72	28845.98
2	3480	862.0809593	90.3056	366312.6834	29539367.77	33928.421
3	3480	898.7127256	98.71594	1496274.112	29446217.29	35485.119

4	3480	848.4757314	269.68185	1622632.675	28897601.35	35001.28
6	3480	878.1044638	97.6896	51889.58161	29567814.84	33802.941
7	3480	901.118828	267.2511	2117180.49	30024508.99	35986.21
10	3480	833.6741146	271.52031	2309387.808	28889875.63	35980.314
12	3480	873.1292865	289.23723	2607549.28	29696378.74	36017.33
13	3480	863.9514056	95.99793	67118.62302	29460878.94	31000.013
17	3480	727.2486453	358.82195	320238.7902	29342188.09	27950.84
22	3480	865.0159135	273.95038	1037967.644	29307606.62	33991.685
23	3480	871.2930856	295.92007	428625.7389	29729503.39	36019.801
24	3480	764.1663105	270.35071	1689083.671	28897487.87	30012.197
27	3480	757.6487513	133.87902	1792317.813	29240528.46	31013.615
28	3480	874.1772852	69.52578	1479522.978	29481346.55	40961.632
30	3480	810.4785955	81.32123	2907797.378	29768437.99	34987.151
31	3480	794.8538771	209.21027	1107104.459	29106378.64	27991.778
1	3540	848.3165363	260.73002	329811.2716	29949433.53	28764.22
2	3540	862.1009265	90.42566	427520.4128	29539074.3	34002.123
3	3540	897.9080143	97.19572	1558155.906	29439842.21	35185.403
4	3540	848.3386381	268.9062	1563069.343	28896996.49	35183.28
6	3540	877.4642866	97.82646	114085.0363	29561489.53	33890.2
7	3540	901.1338871	267.13623	2053268.566	30022215.16	35983.987
10	3540	832.6168574	271.4032	2252908.998	28890981.05	36023.371
12	3540	874.095297	289.12355	2549498.147	29711353.21	35983.11
13	3540	863.9211759	96.09488	67118.62302	29456031.76	31000.007
17	3540	697.7169449	358.82456	319187.4214	29380750.49	25948.994
22	3540	865.0222718	273.80664	977877.789	29310678.16	33982.952
23	3540	870.9792995	296.2161	373321.2964	29749571.27	36019.939
24	3540	764.4175179	269.87389	1635782.526	28897627.01	30007.445
27	3540	758.1087775	134.15189	1830642.473	29212492.34	30993.638
28	3540	872.918125	69.60022	1536548.484	29497256.39	41020.12
30	3540	809.9041204	81.43544	2964423.336	29774785.09	35024.557
1	3600	847.9430718	262.28227	269750.5564	29942995.49	29003.8
2	3600	862.0628885	90.54662	488458.3434	29538685.51	34113.39
3	3600	897.6261311	96.5413	1619608.954	29434367.81	35211.353
4	3600	848.4123718	268.50827	1505039.737	28895959.05	35099.375
6	3600	876.6671606	97.95565	175164.008	29555166.31	33909.395

7	3600	900.9969055	267.01522	1988794.348	30019803.63	35980.665
10	3600	834.0936487	271.24993	2196385.248	28891982.95	35990.194
12	3600	874.3917931	289.00508	2491424.224	29726227.24	35995.799
13	3600	863.9547521	96.20947	67118.62302	29451078.85	31000.015
19	3600	710.5590844	131.82357	1188415.127	29621958.64	25293.747
22	3600	864.5543256	273.85296	917259.4996	29313727.19	33987.835
23	3600	871.1325672	296.26052	318260.1111	29769674.39	36006.078
24	3600	764.6021308	269.06275	1582480.018	28897201.3	30001.373
27	3600	759.3175177	124.59618	1870974.605	29186216.15	31085.351
28	3600	877.6396409	69.71762	1593151.062	29512954.45	40968.308
30	3600	811.2624472	81.53729	3020993.08	29781034.18	34987.606
1	3660	847.7565626	262.38292	209606.2639	29937092.22	29046.764
2	3660	862.0856444	90.6678	549428.6356	29538200.17	34122.184
3	3660	898.4422204	96.50734	1681637.906	29429076.79	35231.988
4	3660	848.4674768	268.49942	1447022.165	28894799.67	35004.51
6	3660	877.205717	98.08121	235571.1119	29548809.38	34015.499
7	3660	900.9067742	266.89523	1924898.597	30017313.94	35981.909
10	3660	833.038734	271.16087	2139804.416	28892881.83	35999.134
12	3660	873.4585778	288.86222	2432766.991	29741129.88	36021.421
13	3660	866.8514451	113.89488	67118.62302	29442260.87	31002.573
19	3660	736.4143674	146.69554	1220424.804	29590861.11	27308.609
22	3660	864.1736103	273.83454	857166.7668	29316778.6	34000.254
23	3660	871.6121145	296.11089	263072.8318	29789735.67	35990.583
24	3660	764.742905	268.65302	1529262.951	28896352.92	29995.563
27	3660	761.6916057	115.66753	1917626.487	29166594.6	31088.362
28	3660	880.2930465	69.8542	1650977.749	29528872.54	40974.717
30	3660	810.1174013	81.61552	3077797.465	29787254.12	35000.414
32	3660	810.4427884	165.04823	1590202.997	29032752.89	29000.003
1	3720	847.6280586	262.04557	149500.5096	29931058.58	29134.554
2	3720	862.0887677	90.79808	610574.9233	29537614.53	34204.382
3	3720	898.7913673	96.75672	1743558.744	29423676.05	35359.021
4	3720	848.506965	268.44415	1389039.868	28893608.44	35144.3
6	3720	876.0595556	98.20933	295927.2733	29542355.48	33993.012
7	3720	900.7744776	266.77508	1861029.865	30014726.49	35984.791
10	3720	833.6260372	271.08996	2082797.611	28893743.1	36009.895

12	3720	873.4904807	288.86543	2374497.504	29755876.45	36003.467
13	3720	865.6934595	127.79352	67118.62302	29417073.42	31001.451
19	3720	764.7163565	145.07384	1250957.655	29557528	29311.023
22	3720	863.9720421	273.7363	797085.4286	29319775.06	34012.769
23	3720	872.0585318	295.94056	207783.2042	29809671.64	35980.989
24	3720	764.834598	268.57832	1475948.151	28895348.05	29988.784
27	3720	760.4869928	113.32077	1966414.363	29150091	31027.09
28	3720	879.155809	69.99073	1708453.491	29544559.12	41020.649
32	3720	810.4518238	165.06297	1604931.617	28990617.42	29000.003
1	3780	847.7561164	261.74866	88872.93567	29924697.48	29259.448
2	3780	862.2369042	96.36446	671321.4667	29534571.38	34120.375
3	3780	898.049681	97.05021	1805452.286	29418038.89	35238.5
4	3780	848.4166106	268.47477	1330557.069	28892410.7	35062.421
6	3780	878.1303431	92.99792	356610.2369	29537973.38	34108.996
7	3780	900.6163018	266.654	1797162.926	30012039.85	35989.631
10	3780	833.6834847	270.98337	2026333.615	28894526.11	35981.158
12	3780	874.4693193	288.77134	2316266.399	29770560.19	35979.219
13	3780	864.8818321	120.81885	67118.62302	29388998.98	30999.517
19	3780	794.4507406	144.72356	1283015.371	29523527.57	31312.82
22	3780	864.287613	273.60643	736449.851	29322703.1	34017.541
23	3780	872.3128626	295.78792	152505.5894	29829443.64	35985.191
24	3780	764.757741	268.49985	1422741.487	28894310.04	29984.739
27	3780	757.983397	113.81014	2015165.206	29134015.77	31007.724
28	3780	880.2169704	70.00229	1766082.505	29560230.33	40973.4
32	3780	810.4556165	165.08578	1619599.741	28948524.03	29000.003
1	3840	848.5458802	261.55734	27793.27965	29918099.05	29841.599
2	3840	862.1171011	97.75044	731975.2167	29528754.48	34118.304
3	3840	897.5103437	97.31479	1867302.433	29412171.74	35422.429
6	3840	879.5231384	89.86891	417744.0634	29537145.55	34258.281
7	3840	900.2659278	266.53194	1732742.931	30009228.51	36002.917
10	3840	832.7620936	270.87418	1969811.801	28895226.2	36024.497
12	3840	874.1659072	288.62645	2257929.401	29785157.14	36007.539
13	3840	865.0835119	109.02704	67118.62302	29371103.52	31001.239
19	3840	838.9926384	144.69048	1316149.715	29488526.24	32932.319
22	3840	864.8047521	273.47397	676329.6211	29325501.19	34005.847

23	3840	872.1697458	295.65023	97085.56537	29849122.92	35998.99
24	3840	764.6291255	267.81203	1369478.934	28893071.49	29984.251
27	3840	758.3371174	114.9272	2063533.748	29117324.27	30990.616
28	3840	881.1540899	70.0972	1823703.568	29575838.25	40971.936
32	3840	810.2982215	158.40927	1634778.632	28906508.79	28994.784
34	3840	805.258346	80.76555	2613093.751	29734047.94	34978.15
35	3840	790.3322563	109.35796	2719242.712	29571102.73	35000.024
2	3900	862.0898832	97.83197	792269.3181	29522559.91	34211.48
3	3900	898.0685327	97.34048	1929127.132	29406190.26	35332.651
6	3900	877.7211829	89.19283	479062.2687	29537663.62	34129.831
7	3900	900.1365314	266.40827	1668903.05	30006340.8	36009.865
10	3900	834.2198102	270.76025	1913323.445	28895841.56	35984.552
12	3900	873.0996146	285.13849	2199320.829	29799098.46	36056.828
13	3900	864.2243649	107.92616	67118.62302	29356721.58	30999.979
16	3900	690.7859867	270.5454	2664063.65	29005671.47	30001.77
19	3900	844.4759194	144.73464	1350611.066	29452045.91	33000.566
22	3900	865.1351589	273.34905	616182.2586	29328199.34	33990.891
24	3900	764.3595126	267.04761	1316238.987	28891185.55	29989.318
27	3900	758.7031083	115.72102	2111864.743	29099877.86	30983.109
28	3900	879.5607302	70.21682	1881423.395	29591366.72	41019.43
32	3900	812.9748292	134.56907	1669367.639	28872201.74	29002.108
34	3900	804.1433066	80.86285	2669217.9	29740767.58	35015.312
35	3900	790.3176434	109.47896	2771511.333	29557349.6	35000.014
36	3900	786.7083782	352.06561	1178916.465	29214621.04	32020.155
2	3960	862.07092	97.7892	852879.2584	29516348.9	34298.571
3	3960	898.7975025	97.40759	1990885.594	29400187.72	35281.048
6	3960	882.6160453	89.73822	540504.1913	29538118.92	34082.388
7	3960	900.0614592	266.27984	1604859.078	30003339.55	36017.855
10	3960	832.8947248	270.65738	1856790.737	28896375.53	36007.845
12	3960	877.2842472	277.79902	2138661.886	29807612.38	36052.306
13	3960	864.0232429	108.50065	67118.62302	29342345.94	31000.012
16	3960	702.691676	270.4754	2612855.201	29006017.91	30005.76
19	3960	845.5318381	144.79425	1384876.721	29415643.4	33000.046
20	3960	880.609956	268.17539	3158855.823	30045903.39	35980.511
22	3960	865.0659988	273.23191	556022.8439	29330802.93	33981.829

27	3960	758.9516385	116.07253	2159535.066	29082230.77	30988.867
28	3960	880.0313536	70.34452	1939313.876	29606823.8	40982.537
32	3960	811.0286414	132.00368	1713144.173	28841260.62	28999.957
34	3960	805.3598552	80.9713	2725896.002	29747473.67	34998.54
35	3960	790.3087195	109.55482	2823741.812	29543518.36	35000.008
36	3960	786.6093231	352.05227	1171311.169	29255869.46	32006.347
2	4020	862.0760512	97.81058	913178.2732	29510171.36	33992.755
3	4020	898.7562295	97.51745	2052623.01	29394109.16	35209.384
6	4020	885.9699759	90.66914	603189.3902	29537937.4	34116.996
7	4020	900.2265511	266.13001	1540948.965	30000231.59	36020.168
10	4020	833.9687144	270.55333	1800022.579	28896833.19	36002.205
12	4020	877.1136895	274.96498	2076880.065	29812419.69	36030.592
13	4020	864.0046143	108.99756	67118.62302	29327456.05	31000.026
14	4020	865.3863663	279.01065	2716768.524	28878019.85	36010.158
16	4020	710.803822	270.39358	2563370.801	29006303.85	30020.281
19	4020	845.7977698	144.85635	1419210.983	29379028.5	33000.006
20	4020	880.4045951	268.29805	3095625.209	30044425.31	35988.957
22	4020	864.41634	273.11737	495294.1015	29333337.98	33995.989
27	4020	758.6709823	116.16976	2207083.641	29064458.67	31005.15
28	4020	881.2936371	70.46729	1997289.911	29622188.87	40961.457
32	4020	810.5972832	132.53836	1754979.906	28812029.98	29000.002
34	4020	804.8883394	81.07866	2782115.077	29754043.96	34986.561
35	4020	790.3252287	109.62395	2875926.843	29529645.94	35000.005
2	4080	862.0801785	97.89283	973452.787	29503956.73	34048.429
3	4080	897.7702518	97.64032	2113813.624	29387984.11	35199.424
6	4080	890.0387096	94.70957	664971.382	29535938	34321.493
7	4080	900.6055931	267.89442	1476997.482	29997866.99	36015.537
10	4080	862.006668	270.45259	1742510.957	28897217.17	36017.501
12	4080	874.9247721	274.43002	2015082.255	29816048.25	35978.111
13	4080	863.9487284	109.26457	67118.62302	29312391.82	31000.001
14	4080	867.4291551	274.22577	2658386.334	28883272.98	36053.634
16	4080	722.0532711	270.34625	2512197.821	29006553.55	29996.594
19	4080	845.8657029	144.91634	1453299.965	29342536.36	32999.999
20	4080	879.1233483	268.78933	3033002.595	30043276.82	36022.412
22	4080	864.074109	272.99463	435106.4129	29335755.21	34011.984

27	4080	758.0658313	116.18579	2254594.072	29046653.82	31018.189
28	4080	880.4658353	70.57974	2055746.05	29637570.4	41002.366
32	4080	810.4493698	133.0566	1796487.39	28782390.39	29000.013
34	4080	804.2627751	81.18297	2838345.62	29760533.89	35024.412
35	4080	790.3135161	109.71845	2927953.884	29515741.73	34999.999
2	4140	862.0927835	98.01127	1033950.448	29497631.19	34194.322
3	4140	897.7256324	97.76863	2175485.241	29381704.28	35224.59
6	4140	892.1978435	97.73403	726535.2141	29530700.85	34199.999
7	4140	900.9800616	268.84992	1413056.786	29996642.26	36006.568
10	4140	873.5493783	270.33617	1683522.992	28897527.69	35981.766
12	4140	874.5919112	274.78549	1953553.169	29819693.59	36001.373
13	4140	863.9689187	111.88897	67118.62302	29296832.26	30999.966
14	4140	868.6595357	271.46601	2599659.665	28885281.77	36012.798
16	4140	734.2328122	270.26419	2460981.887	29006762.08	30012.214
19	4140	845.8741806	146.31218	1487222.951	29305999.25	32998.701
20	4140	879.1738798	269.17214	2970337.458	30042492.8	36000.319
22	4140	864.2651917	272.55188	374882.1729	29337966.07	34018.589
27	4140	757.7720124	116.21158	2302058.213	29028840.22	31015.708
28	4140	879.4679218	70.68938	2113780.47	29652735.56	41008.463
32	4140	810.4581821	133.31285	1837988.958	28752319.88	29000.035
34	4140	805.5690087	81.29533	2894607.783	29766945.67	34987.197
36	4140	750.8384886	346.72778	1147179.246	29382050.16	28513.83
38	4140	796.7068103	70.50582	2018225.886	29627671.16	34980.811
2	4200	862.0769436	98.12897	1094149.015	29491239.94	34138.129
3	4200	898.348408	97.89585	2237180.014	29375316.35	35179.493
6	4200	888.8663342	98.72337	788111.318	29523912.38	35996.209
7	4200	901.2894973	268.98332	1349066.656	29995804.7	35995.719
10	4200	876.5319637	269.7269	1624162.464	28897615.45	35996.975
12	4200	873.4727445	275.22449	1892126.975	29823687.77	36022.66
13	4200	867.0854739	118.99452	67118.62302	29276370.11	30884.019
14	4200	865.7732167	270.75992	2540430.811	28886055.53	36006.202
16	4200	735.9166377	270.15022	2409416.125	29006902.54	30003.329
19	4200	847.0124221	163.49236	1509543.244	29264767.52	33001.692
20	4200	880.1848444	269.30982	2907693.208	30041906.24	35980.224
22	4200	864.9440762	272.06857	314650.9973	29339765.2	34006.009

27	4200	757.300162	114.0195	2349559.287	29011172.03	31016.8
28	4200	880.8276988	70.80865	2171883.001	29667813.2	40961.038
32	4200	807.1453014	133.43757	1879005.766	28722393.21	29007.375
34	4200	804.5221255	81.40756	2950901.584	29773276.41	35000.056
36	4200	730.2163948	313.53575	1118538.374	29416265.61	26908.483
38	4200	795.6560228	70.60438	2071382.127	29641630.67	34997.571
2	4260	862.0777244	98.2424	1154355.791	29484753.46	33721.308
3	4260	898.9372729	98.02535	2298808.218	29368830.28	35482.348
6	4260	889.0880928	98.56526	849280.6128	29516911.57	35400.954
7	4260	901.3307703	268.64596	1284536.106	29994839.9	35981.807
10	4260	876.5389913	268.94958	1564684.926	28897041.27	36018.851
11	4260	835.3178942	44.33983	879401.7935	29122292.88	27667.036
12	4260	873.7213862	275.48742	1830641.589	29827966.75	36000.713
13	4260	863.3163596	119.29274	67118.62302	29253597.37	29820.643
14	4260	864.7417271	270.94267	2481764.391	28886703.42	36010.938
16	4260	737.5878582	270.54328	2357739.973	29007053.83	29988.699
19	4260	846.1789313	165.63875	1524830.186	29221482.68	32999.985
20	4260	879.5895098	269.26512	2845098.033	30041344.52	36012.785
22	4260	864.9876917	271.92034	252800.1187	29341313.01	33983.461
27	4260	763.7221242	94.15417	2402532.949	29002390.91	31091.062
28	4260	881.1306647	70.94943	2230066.662	29682796.39	40981.364
32	4260	803.8478144	133.55807	1919587.33	28692619.71	28985.062
34	4260	805.1766924	81.52635	3007710.501	29779571.44	35010.664
36	4260	697.7129292	300.60104	1076299.094	29438352.62	25371.051
2	4320	862.0886562	98.35411	1214556.18	29478175.5	33689.385
3	4320	898.9210983	98.11744	2360610.089	29362220.87	35508.498
6	4320	889.3957437	97.98221	910611.5582	29510260.6	35411.554
7	4320	901.0833556	268.2577	1220623.386	29993536.79	35982.886
10	4320	876.3512551	268.48526	1505253.302	28895982.85	36016.28
11	4320	807.2739169	44.44632	921487.7211	29154953.3	25614.173
12	4320	874.5901264	275.54056	1769188.837	29832356.27	35979.419
13	4320	785.6176564	118.95403	67118.62302	29232026.92	27639.44
14	4320	865.9138794	271.30022	2423105.087	28887598.37	35979.408
16	4320	736.4772808	271.10044	2306080.695	29007664.33	30020.701
19	4320	845.9643118	165.46189	1539477.776	29178288.68	33000.001

20	4320	878.9169835	269.13213	2782460.517	30040702.25	36015.175
22	4320	864.4096471	272.35566	192492.6034	29343047.79	33999.793
27	4320	762.695989	86.06187	2456944.292	29003218.23	31115.133
28	4320	881.7425085	95.78386	2290981.169	29689225.86	41063.172
29	4320	897.7264132	90.79208	145986.4132	47408610.77	40955.657
32	4320	802.385859	133.64958	1959991.549	28662832.01	29016.271
34	4320	805.2513184	81.59206	3064075.739	29785757.59	34980.89
2	4380	862.0753819	98.46503	1274942.435	29471485.83	33650.851
3	4380	898.3284408	98.19407	2422134.967	29355585.06	35574.118
6	4380	888.2115442	97.80969	971960.3801	29503922.74	35328.849
7	4380	900.7424632	268.05636	1156714.695	29992019.1	35992.127
10	4380	876.8959467	268.48368	1445821.951	28894778.53	35993.982
12	4380	874.5836566	275.46397	1707738.121	29836725.69	35998.277
13	4380	736.444374	128.95525	67118.62302	29211009.91	25434.732
14	4380	865.0955592	271.50007	2364427.54	28888716.7	36018.13
16	4380	737.3192493	271.21755	2254428.07	29008486.3	29984.168
19	4380	845.9048565	165.1951	1554435.184	29134975.6	33000.032
20	4380	879.6200741	268.96856	2719264.664	30039931.41	35988.612
27	4380	758.8729967	86.32288	2509891.77	29006269.94	31011.652
28	4380	884.2581517	111.06262	2350562.177	29677228.66	41069.209
29	4380	896.8887951	89.20414	210215.8331	46829699.93	40894.33
32	4380	802.3050979	124.87648	2001314.44	28633969.79	29023.466
34	4380	804.2561937	81.70344	3120448.757	29791871.94	35023.231
18	4400	777.982269	208.49433	491105.5822	29257877.73	26000.013
2	4440	862.0776129	98.57552	1335079.769	29464732.87	33601.338
3	4440	897.7435917	98.33585	2483618.278	29348857.08	35548.539
6	4440	889.5136505	97.87653	1033092.22	29497631.31	35285.309
7	4440	900.4131719	267.90956	1092827.76	29990362.21	36004.821
10	4440	877.5804087	268.19374	1386339.592	28893525.41	35979.842
12	4440	873.8986369	275.33332	1645728.709	29841044.01	36017.955
14	4440	864.9521077	271.52245	2305764.198	28889916.04	36001.008
16	4440	737.4294593	271.10929	2202703.981	29009292.43	30006.817
19	4440	845.8971596	165.07549	1569486.419	29091891.72	33000.03
20	4440	880.2922657	268.81512	2656684.183	30039042.31	35987.073
27	4440	760.5983183	89.98959	2562792.992	29007350.36	31088.286

28	4440	883.7102251	114.8401	2407169.95	29658706.33	41011.287
29	4440	896.4148253	88.81174	272130.4783	46686643.76	40895.125
32	4440	811.5822569	104.21753	2053079.054	28617592.77	29125.297
2	4500	862.0814055	98.687	1395210.234	29457889.4	33458.499
3	4500	897.9304356	98.46588	2545105.412	29342014.89	35428.759
6	4500	888.6778172	98.02981	1094386.67	29491220.24	35221.83
7	4500	900.3141167	267.79001	1028358.012	29988582.13	36019.524
10	4500	877.7724953	267.2651	1326747.323	28891655.55	35989.521
12	4500	873.498066	275.19198	1584144.82	29845219.8	36015.621
14	4500	865.9873899	271.41509	2246782.653	28891080.22	35981.45
16	4500	737.8845774	270.94955	2150815.444	29009999.58	30012.133
19	4500	845.8887935	165.04688	1584640.563	29048639.48	33000.017
20	4500	879.3851528	268.67446	2594120.963	30038035.86	36018.893
27	4500	758.4892697	91.53209	2615853.537	29006646.6	30990.254
28	4500	882.4769442	113.33853	2463365.285	29639841.64	40986.482
29	4500	902.5718596	89.02902	334730.3673	46765856.93	41010.124
34	4500	804.3429785	81.96943	3233824.257	29803878.69	35010.372
2	4560	862.0891024	98.80153	1455254.122	29450963.18	33388.553
3	4560	898.4855012	98.57087	2606535.064	29335057.05	35403.84
6	4560	888.7730796	98.2013	1155421.619	29484697.36	35117.468
7	4560	900.7459212	267.67815	964446.7143	29986724.08	36014.956
12	4560	874.0990897	275.05393	1522520.876	29849286.14	35991.04
14	4560	865.0619831	271.25172	2188140.052	28892126.29	36019.746
16	4560	746.2704635	270.80658	2098734.307	29010603.8	29984.236
19	4560	845.9070874	165.05622	1599708.527	29005574.2	33000.011
20	4560	879.0583155	268.39444	2531444.225	30036881.63	36011.021
27	4560	758.8183379	91.30106	2668684.195	29005550.63	30984.602
28	4560	882.9493524	110.93072	2520393.975	29622626.76	41038.717
29	4560	913.1059479	89.34686	398629.4251	46881730.96	41000.026
38	4560	796.7387132	81.37903	2394918.675	29708352.81	34997.447
2	4620	862.0982494	97.6281	1515263.996	29444204.14	34539.721
3	4620	899.0720235	98.48966	2667442.215	29328184.1	34388.568
6	4620	889.6451663	98.35373	1216665.96	29478019.2	35218.599
7	4620	901.2639527	267.56518	900580.5146	29984776.53	36001.625
12	4620	874.7565569	274.9273	1460968.81	29853243.59	35980.755

14	4620	865.0830657	271.15241	2129669.944	28893050.08	35997.261
16	4620	748.5374649	270.69292	2045405.236	29011133.11	29991.646
19	4620	845.8371465	165.07795	1614798.074	28962319.02	32999.993
20	4620	879.9834993	268.01673	2468883.786	30035426.4	35981.379
27	4620	759.0522553	91.30106	2721607.349	29004962.44	30983.735
28	4620	880.4869179	109.24869	2578745.866	29606858.03	41044.775
29	4620	912.4818337	89.56724	462466.4623	46962074.28	41000.017
38	4620	796.5593431	81.23445	2450521.368	29714629.23	34979.351
2	4680	862.1032691	96.67801	1575559.276	29438675.68	34655.284
3	4680	899.03287	98.5315	2728880.951	29321259.55	34428.556
6	4680	888.312161	98.47758	1277736.327	29471245.44	35228.549
7	4680	901.5231916	267.44795	836720.5328	29982735.73	35987.333
12	4680	874.5711632	274.81097	1399403.012	29857104.87	36002.714
14	4680	866.0585579	271.06734	2070786.759	28893926.39	35983.571
16	4680	753.9274913	270.59676	1992683.93	29011583.11	30017.08
19	4680	845.8458473	165.10089	1629772.577	28919248.72	33000.025
20	4680	880.3530597	267.78262	2405762.513	30033721.34	35986.994
26	4680	687.2764459	335.05231	2654296.944	29604553	24016.461
28	4680	880.7197198	108.62195	2636903.818	29592081.3	41014.733
29	4680	905.4866235	89.72533	526128.738	47019708.71	40999.465
38	4680	795.3961147	80.93132	2506106.495	29721105.06	35014.208
2	4740	862.0984725	96.69851	1636009.02	29433379.12	34589.673
3	4740	898.6405537	98.65136	2790437.968	29314246.23	34501.488
6	4740	889.0671216	98.59752	1339167.319	29464330.17	35302.482
7	4740	901.3584344	267.32833	772869.9678	29980598.24	35981.391
12	4740	873.7573049	274.69483	1337792.89	29860874.74	36021.724
14	4740	865.0149096	270.95993	2012160.309	28894720.11	36021.269
16	4740	754.7448076	270.49122	1939737.155	29011964.74	30016.161
19	4740	849.3580652	137.56626	1658123.201	28880734.13	33004.241
20	4740	879.5803628	267.6384	2343226.264	30031885.44	36016.683
26	4740	688.2839525	335.00873	2632919.635	29638721.86	24002.918
28	4740	881.9276791	108.83211	2695073.17	29577428.11	40983.223
29	4740	901.3129225	89.85957	589373.9129	47068648.21	40999.842
38	4740	796.1259769	80.75446	2561445.334	29727732.28	35016.984
2	4800	862.0879869	96.85956	1696330.157	29427995.13	34495.482

6	4800	889.5490114	98.70928	1400052.635	29457381.87	35290.482
7	4800	900.6793267	267.20534	708443.2741	29978340.13	35999.005
8	4800	633.534246	273.27698	2082800.811	29978090.36	21771.86
12	4800	873.670297	274.5705	1276149.06	29864550.73	36010.491
14	4800	864.9623702	270.84208	1953203.539	28895427.26	36002.82
16	4800	762.0850375	293.57383	1888133.264	29019599.46	30077.902
19	4800	846.8343906	132.01269	1700206.167	28849912.38	33000.212
20	4800	879.1071738	267.52774	2280695.707	30029950.02	36014.413
26	4800	688.303585	334.96664	2611518.765	29672812.34	23983.946
28	4800	881.6156778	108.59464	2753174.702	29562746.7	41017.105
29	4800	900.0397073	89.93575	652366.0048	47096420.94	40999.965
38	4800	796.9109441	80.74158	2616790.791	29734420.35	34982.467
2	4860	862.0918911	97.00743	1756555.011	29422492.55	34856.432
6	4860	888.3575612	98.82456	1461139.024	29450315.09	35304.598
7	4860	900.4208687	267.07571	644604.1678	29975997.62	36014.674
8	4860	658.2967993	273.29958	2034407.687	29980136.16	23771.609
12	4860	873.1833875	275.8123	1214472.898	29868272.94	36015.245
14	4860	866.0665894	270.72514	1894260.58	28896042.58	35979.78
16	4860	762.2626228	309.49118	1843476.158	29041939.42	30113.757
19	4860	846.1136754	132.23799	1743489.113	28819933.77	32999.973
20	4860	879.861019	267.42492	2218183.644	30027932.12	35985.877
26	4860	695.2842939	334.92761	2589846.863	29707219.62	23514.495
28	4860	880.4243392	108.51305	2811840.326	29548061.55	41044.445
29	4860	899.6915642	86.46849	715292.3594	45832371.67	41000.024
38	4860	795.8503404	80.82665	2672340.124	29741097.68	34996.154
2	4920	862.095126	97.13528	1816681.211	29416888.71	34833.239
6	4920	888.6893067	111.29103	1521406.957	29440750.11	35311.39
7	4920	900.3462427	266.42492	580800.6461	29973491.04	36027.739
8	4920	684.3737292	273.23376	1984242.371	29982235.38	25782.653
12	4920	876.9780464	281.46047	1153195.353	29875567.89	36072.982
14	4920	865.4818518	270.61841	1835537.898	28896567.98	36013.691
16	4920	758.7773996	308.1944	1802463.487	29068607.7	30088.556
19	4920	845.9129995	132.87557	1786113.134	28789765.16	33000.023
20	4920	880.4306975	267.31982	2155676.054	30025832.47	35985.836
26	4920	676.876439	334.8857	2568113.244	29741611	21569.513

28	4920	880.4458681	108.56093	2869968.158	29533507.6	41023.096
29	4920	899.5388542	86.10773	778326.1042	45700850.41	40999.988
38	4920	795.7100123	80.94633	2727982.769	29747704.26	35024.227
2	4980	862.0856444	97.2559	1877117.713	29411153.76	34859.041
6	4980	896.664694	131.60019	1572600.302	29414995.16	35348.999
7	4980	903.1273714	263.48573	517120.2183	29969153.58	36095.359
8	4980	711.7523194	273.14433	1932726.291	29984337.71	27786.046
12	4980	877.1934467	283.79291	1092657.085	29885798.5	35992.618
14	4980	864.8928754	270.51283	1776937.5	28897007.96	36010.016
16	4980	758.9803064	302.64812	1758775.321	29091876.4	30076.8
19	4980	845.8891281	133.25147	1828511.013	28759185.09	33000.034
20	4980	880.0535518	267.21051	2092643.134	30023627.86	36006.295
28	4980	881.6246017	108.67237	2928017.233	29518892.58	40986.635
29	4980	899.4963542	86.24427	841190.5148	45750628.42	41000.008
38	4980	796.955452	81.07311	2783722.303	29754228.38	34988.03

2.0 Traffic Level

Aircraft #	Time	velocity	heading	x	y	altitude
1	3120	848.6760573	282.23748	749864.7717	1334294.789	29669.001
2	3120	861.9488859	89.71427	−0.00215094	929121.4287	33341.284
3	3120	897.1924303	98.10239	1125715.088	877601.9606	34721.82
4	3120	848.0048846	270.87631	1971377.649	284935.0703	34826.699
7	3120	900.569786	268.2081	2502043.561	1425959.752	36007.535
10	3120	835.585053	273.03904	2648933.063	273206.2686	36068.272
13	3120	858.9941876	93.63356	67118.72084	875273.3299	30984.123
22	3120	864.0366287	274.2483	1398480.326	677239.3737	33999.023
23	3120	870.9713796	305.43727	749797.1839	988478.658	36009.048
24	3120	763.5278066	270.9475	2008685.789	284461.0144	30017.528
27	3120	764.9963434	133.66676	1566770.697	803967.5634	31109.949
28	3120	949.6677732	54.82297	1132948.843	768543.414	40999.737
34	3120	773.1237715	78.66421	1942711.51	1033830.985	34994.617
35	3120	785.057348	70.63219	2086463.609	1035289.984	35006.737
38	3120	793.0551566	19.82063	1140435.528	762062.5642	35002.444

48	3120	862.0033215	302.4054	1299290.196	704074.437	30000.009
50	3120	898.8751403	53.23831	855016.1554	613302.422	34981.269
51	3120	805.8126308	91.39866	37480.33192	1120842.211	36014.151
58	3120	902.1426207	97.469	1679296.585	942169.8441	33000.021
61	3120	867.52676	262.09429	2595878.343	1366405.142	33996.749
62	3120	874.8503692	39.25718	242111.0229	822399.9114	34015.254
64	3120	830.1245279	93.90516	1496987.535	1124395.35	31000.063
1	3180	848.6578749	282.18214	690543.8181	1343704.475	29561.393
2	3180	862.0112415	89.76837	61297.96604	929322.5585	33362.153
3	3180	898.017555	98.27674	1187532.955	870932.4673	34996.692
4	3180	848.1555868	270.76222	1913204.467	285570.5183	34884.372
7	3180	900.7835131	267.89825	2437496.372	1424335.602	36000.962
10	3180	834.0422249	271.22564	2591839.207	274651.761	35997.895
12	3180	874.2120883	289.81542	2897733.602	1009677.982	35990.429
13	3180	858.9753359	93.89728	67118.72084	872173.4655	30996.487
22	3180	863.8767796	274.3134	1338514.097	680630.4606	34007.128
23	3180	871.5992864	305.10825	700064.2581	1014675.208	35986.916
24	3180	763.5297029	270.84216	1955456.323	285094.152	30017.875
27	3180	763.4619929	138.27954	1604032.295	774057.8302	31061.101
28	3180	920.4262106	67.95161	1191025.945	790471.1599	40998.61
30	3180	809.9906821	80.78351	2623900.185	1125068.044	35000.27
34	3180	793.6564033	78.78609	1998061.323	1042031.17	35036.512
35	3180	785.3332075	70.73348	2138595.633	1048873.222	34978.964
38	3180	792.5078994	65.75914	1180002.912	788849.8299	35006.292
40	3180	861.989378	268.49793	1497216.694	285534.2332	33985.722
1	3240	848.6737148	282.14107	631192.6643	1353092.797	29648.482
2	3240	862.0295355	89.87832	122266.1584	929463.1953	33583.1
3	3240	898.6621941	98.42307	1249314.249	864135.546	35003.282
4	3240	848.3472274	270.65391	1855353.219	286116.6545	34223.84
7	3240	900.8138543	267.70521	2373534.478	1422528.529	36000.603
10	3240	833.2091802	270.95334	2535290.897	275410.3317	36020.367
12	3240	873.8030398	289.68691	2838732.58	1025439.031	36011.359
13	3240	858.1334789	94.36799	67118.72084	868929.8684	31013.214
17	3240	801.0276437	358.80651	324825.3573	566167.5346	34100.02
22	3240	863.7859791	274.33976	1278554.015	684060.1098	34014.607

23	3240	873.3719046	299.90008	648512.4302	1039139.383	36089.123
24	3240	763.6017633	270.7422	1902223.284	285654.3512	30018.339
27	3240	758.5448209	137.40709	1640000.225	743955.7964	30987.31
28	3240	892.592837	69.85609	1249822.952	807176.3353	40998.373
30	3240	810.2379852	80.88396	2680497.214	1131828.695	35019.623
32	3240	677.0513471	121.19575	1466202.149	699264.632	26227.102
34	3240	803.4551635	78.89918	2053341.828	1050131.83	35000.224
35	3240	786.4349727	70.85735	2190596.952	1062335.191	35010.729
38	3240	788.887814	71.14581	1231608.693	803151.5135	35000.045
40	3240	861.6334265	268.4843	1438167.02	284343.5981	33996.853
1	3300	847.2058473	277.67594	571663.3126	1361852.367	29454.383
2	3300	862.0406903	90.00327	183220.4601	929507.4031	33848.954
3	3300	897.810744	98.54468	1311145.801	857220.8852	35129.032
4	3300	848.4269846	270.5473	1797245.068	286581.9538	34580.4
7	3300	900.8738674	267.57364	2309564.434	1420593.727	35999.753
10	3300	834.0235962	271.2187	2478838.149	276225.4488	35978.6
12	3300	873.1498114	289.5678	2781035.192	1040736.007	36012.656
13	3300	862.66592	95.64421	67118.72084	864778.7098	31000.19
17	3300	803.1264299	358.79974	323655.5234	608579.1304	33681.309
22	3300	863.8418649	274.29758	1218563.131	687481.3567	34019.432
23	3300	874.9071474	296.39061	594348.5207	1060306.745	36049.153
24	3300	763.7023801	270.64564	1848861.827	286146.0412	30018.296
27	3300	758.9993812	135.43983	1676953.398	714772.5328	30984.577
28	3300	881.4853891	69.76319	1307580.654	823084.3007	40999.42
30	3300	811.1138645	80.99406	2737007.372	1138498.896	34979.338
32	3300	756.5079442	154.3281	1500638.928	673557.8772	28996.901
34	3300	804.4189431	79.01105	2108859.906	1058181.547	34979.335
35	3300	793.1516461	79.14781	2243500.629	1075442.256	34994.121
38	3300	784.5531485	70.6663	1283889.092	816703.6299	35015.141
40	3300	861.3452966	268.45629	1379111.941	283121.3662	34010.004
1	3360	852.7368711	264.85316	510316.6897	1361941.274	29876.77
2	3360	862.0470486	90.125	244424.9423	929453.867	34002.228
3	3360	897.4114001	98.65704	1372905.676	850214.8747	35382.902
4	3360	848.4117025	270.43835	1738745.246	286965.9587	34430.32
7	3360	901.0253504	267.46485	2245040.527	1418545.626	35990.948

10	3360	832.6961684	271.46921	2422338.161	277256.6417	36010.955
12	3360	874.2647393	289.45168	2723263.249	1055944.549	35979.051
13	3360	863.6201064	95.86362	67118.72084	860132.6416	31000.044
17	3360	792.1105634	358.79676	322482.3508	650885.0996	31949.82
22	3360	864.410651	274.20143	1158018.726	690874.4862	34012.667
23	3360	872.7016093	295.36093	538819.0544	1080149.479	35981.351
24	3360	763.8306609	270.55063	1795625.717	286568.5978	30017.538
27	3360	758.6132001	134.18445	1714971.457	686399.4024	31004.469
28	3360	873.541793	69.61061	1364606.638	838931.552	41009.692
30	3360	809.8493501	81.09874	2793504.5	1145085.033	35007.622
31	3360	732.549656	209.46576	1160983.484	568143.9077	24733.408
32	3360	799.9652553	165.37127	1517979.62	633214.0265	29002.172
34	3360	803.7592449	79.1184	2164503.064	1066163.753	35013.104
35	3360	798.3170137	106.90364	2298602.018	1069731.661	35003.463
38	3360	779.8277284	69.90164	1335923.801	830724.9777	35002.65
40	3360	861.413899	268.4707	1320159.676	281915.9076	34018.516
1	3420	851.878728	259.6634	449984.9782	1355380.947	28763.118
2	3420	862.0519567	90.24914	305406.8022	929299.3958	34122.98
3	3420	898.3201862	98.77571	1434585.778	843122.1248	35763.983
4	3420	848.448402	270.3215	1680686.631	287260.285	34883.28
7	3420	901.0605997	267.36042	2181103.225	1416430.308	35988.59
10	3420	833.5940227	271.56765	2365862.554	278420.032	36008.73
12	3420	874.0468849	289.3438	2665448.941	1071060.469	36006.881
13	3420	863.8737678	95.92507	67118.72084	855384.1376	31000.012
17	3420	758.5852014	358.79392	321335.0498	692093.3349	29950.076
22	3420	864.8018518	274.08054	1097994.71	694150.1236	34002.571
23	3420	872.1395161	295.50005	483534.9425	1099609.136	36000.674
24	3420	763.9625113	270.4538	1742399.22	286922.9065	30015.936
27	3420	757.7996765	133.77598	1753457.78	658427.7357	31019.762
28	3420	871.1008875	69.52264	1422816.075	855196.2759	41004.486
30	3420	810.572854	81.20664	2850107.769	1151601.782	35013.43
31	3420	760.6412645	209.69426	1134310.424	532755.6309	26744.393
32	3420	808.1120928	165.93937	1531904.163	591219.3967	29000.386
34	3420	804.8803079	79.24427	2220705.374	1074136.021	35008.499
35	3420	795.307322	109.71352	2351686.501	1056176.348	34999.769

38	3420	788.525058	69.46478	1387540.047	845088.4973	34987.067
1	3480	849.061123	259.23113	390149.017	1346985.659	28845.98
2	3480	862.0809593	90.3056	366312.7812	929086.706	33928.421
3	3480	898.7127256	98.71594	1496274.21	835936.2299	35485.119
4	3480	848.4757314	269.68185	1622632.773	287320.2884	35001.28
6	3480	878.1044638	97.6896	51889.67944	957533.7823	33802.941
7	3480	901.118828	267.2511	2117180.588	1414227.932	35986.21
10	3480	833.6741146	271.52031	2309387.906	279594.5666	35980.314
12	3480	873.1292865	289.23723	2607549.378	1086097.677	36017.33
13	3480	863.9514056	95.99793	67118.72084	850597.8812	31000.013
17	3480	727.2486453	358.82195	320238.888	731907.0352	27950.84
22	3480	865.0159135	273.95038	1037967.742	697325.5621	33991.685
23	3480	871.2930856	295.92007	428625.8367	1119222.332	36019.801
24	3480	764.1663105	270.35071	1689083.768	287206.8149	30012.197
27	3480	757.6487513	133.87902	1792317.91	630247.3977	31013.615
28	3480	874.1772852	69.52578	1479523.075	871065.4929	40961.632
30	3480	810.4785955	81.32123	2907797.476	1158156.93	34987.151
31	3480	794.8538771	209.21027	1107104.557	496097.5795	27991.778
32	3480	809.9093632	165.4585	1546133.349	548932.6928	29000.089
34	3480	805.1312922	79.79153	2276479.723	1081815.315	34977.781
35	3480	791.4366986	109.40269	2404231.697	1042274.684	34999.817
38	3480	791.7230437	69.36758	1440131.733	859909.538	34990.458
1	3540	848.3165363	260.73002	329811.3695	1339152.471	28764.22
2	3540	862.1009265	90.42566	427520.5106	928793.2437	34002.123
3	3540	897.9080143	97.19572	1558156.004	829561.1553	35185.403
4	3540	848.3386381	268.9062	1563069.44	286715.4277	35183.28
6	3540	877.4642866	97.82646	114085.1341	951208.4738	33890.2
7	3540	901.1338871	267.13623	2053268.664	1411934.103	35983.987
10	3540	832.6168574	271.4032	2252909.096	280699.9892	36023.371
12	3540	874.095297	289.12355	2549498.245	1101072.15	35983.11
13	3540	863.9211759	96.09488	67118.72084	845750.6996	31000.007
17	3540	697.7169449	358.82456	319187.5192	770469.4286	25948.994
19	3540	679.4334666	101.26308	1141889.324	1025858.821	23281.581
22	3540	865.0222718	273.80664	977877.8868	700397.1007	33982.952
23	3540	870.9792995	296.2161	373321.3942	1139290.209	36019.939

24	3540	764.4175179	269.87389	1635782.624	287345.9534	30007.445
27	3540	758.1087775	134.15189	1830642.57	602211.2853	30993.638
28	3540	872.918125	69.60022	1536548.582	886975.3296	41020.12
30	3540	809.9041204	81.43544	2964423.434	1164504.033	35024.557
32	3540	810.3358133	165.16837	1560705.291	506776.6926	29000.024
34	3540	803.9765415	80.2019	2332376.548	1089105.897	35009.775
35	3540	790.5647235	109.09809	2456766.57	1028652.309	34999.985
38	3540	792.556423	69.45194	1492865.19	874752.252	35025.16
1	3600	847.9430718	262.28227	269750.6542	1332714.434	29003.8
2	3600	862.0628885	90.54662	488458.4412	928404.4468	34113.39
3	3600	897.6261311	96.5413	1619609.052	824086.7503	35211.353
4	3600	848.4123718	268.50827	1505039.835	285677.9863	35099.375
6	3600	876.6671606	97.95565	175164.1058	944885.2491	33909.395
7	3600	900.9969055	267.01522	1988794.446	1409522.57	35980.665
10	3600	834.0936487	271.24993	2196385.345	281701.8938	35990.194
12	3600	874.3917931	289.00508	2491424.322	1115946.182	35995.799
13	3600	863.9547521	96.20947	67118.72084	840797.7893	31000.015
17	3600	669.5714584	358.82226	318169.3204	807731.4898	23949.375
19	3600	710.5590844	131.82357	1188415.225	1011677.579	25293.747
22	3600	864.5543256	273.85296	917259.5975	703446.1305	33987.835
23	3600	871.1325672	296.26052	318260.209	1159393.33	36006.078
24	3600	764.6021308	269.06275	1582480.116	286920.2407	30001.373
27	3600	759.3175177	124.59618	1870974.703	575935.0926	31085.351
28	3600	877.6396409	69.71762	1593151.16	902673.3939	40968.308
30	3600	811.2624472	81.53729	3020993.178	1170753.116	34987.606
32	3600	810.4340876	165.06464	1575433.624	464643.374	29000.007
34	3600	804.658884	80.41394	2388349.892	1096180.816	35016.309
35	3600	790.3772103	109.02039	2509589.905	1015085.711	35000.024
38	3600	796.0889428	69.60253	1546176.216	889647.7674	34993.725
1	3660	847.7565626	262.38292	209606.3618	1326811.162	29046.764
2	3660	862.0856444	90.6678	549428.7334	927919.1134	34122.184
3	3660	898.4422204	96.50734	1681638.004	818795.73	35231.988
4	3660	848.4674768	268.49942	1447022.263	284518.6151	35004.51
6	3660	877.205717	98.08121	235571.2097	938528.3165	34015.499
7	3660	900.9067742	266.89523	1924898.694	1407032.885	35981.909

10	3660	833.038734	271.16087	2139804.514	282600.7748	35999.134
12	3660	873.4585778	288.86222	2432767.088	1130848.82	36021.421
13	3660	866.8514451	113.89488	67118.72084	831979.8138	31002.573
19	3660	736.4143674	146.69554	1220424.902	980580.0528	27308.609
22	3660	864.1736103	273.83454	857166.8647	706497.5388	34000.254
23	3660	871.6121145	296.11089	263072.9296	1179454.609	35990.583
24	3660	764.742905	268.65302	1529263.049	286071.8585	29995.563
27	3660	761.6916057	115.66753	1917626.585	556313.5373	31088.362
28	3660	880.2930465	69.8542	1650977.847	918591.4803	40974.717
30	3660	810.1174013	81.61552	3077797.563	1176973.064	35000.414
32	3660	810.4427884	165.04823	1590203.095	422471.8309	29000.003
34	3660	805.1868434	80.52035	2444861.434	1103212.001	34977.952
35	3660	790.3290214	109.06014	2562019.013	1001618.951	35000.032
38	3660	796.0742184	69.74217	1598739.55	904210.2824	34980.199
47	3660	664.2268323	210.57751	531412.4673	867222.3361	24042.717
1	3720	847.6280586	262.04557	149500.6074	1320777.523	29134.554
2	3720	862.0887677	90.79808	610575.0211	927333.4682	34204.382
3	3720	898.7913673	96.75672	1743558.842	813394.991	35359.021
4	3720	848.506965	268.44415	1389039.966	283327.3835	35144.3
6	3720	876.0595556	98.20933	295927.3711	932074.421	33993.012
7	3720	900.7744776	266.77508	1861029.962	1404445.427	35984.791
10	3720	833.6260372	271.08996	2082797.709	283462.0424	36009.895
12	3720	873.4904807	288.86543	2374497.601	1145595.394	36003.467
13	3720	865.6934595	127.79352	67118.72084	806792.3593	31001.451
19	3720	764.7163565	145.07384	1250957.752	947246.9378	29311.023
22	3720	863.9720421	273.7363	797085.5264	709494.0039	34012.769
23	3720	872.0585318	295.94056	207783.3021	1199390.579	35980.989
24	3720	764.834598	268.57832	1475948.249	285066.9902	29988.784
27	3720	760.4869928	113.32077	1966414.461	539809.9447	31027.09
28	3720	879.155809	69.99073	1708453.589	934278.0562	41020.649
32	3720	810.4518238	165.06297	1604931.714	380336.3579	29000.003
34	3720	804.0606491	80.59228	2500919.31	1110121.904	35013.08
35	3720	790.3235555	109.14186	2614387.562	988110.0272	35000.032
36	3720	787.3658454	352.1719	1201772.841	479179.3468	31982.139
38	3720	795.4391724	69.8629	1650644.6	918481.9165	35001.286

46	3720	714.3570898	202.0303	703694.4356	809518.6742	23783.685
47	3720	698.0239265	210.57221	506339.0187	835422.6074	25866.202
1	3780	847.7561164	261.74866	88873.03349	1314416.425	29259.448
2	3780	862.2369042	96.36446	671321.5645	924290.3173	34120.375
3	3780	898.049681	97.05021	1805452.384	807757.8294	35238.5
4	3780	848.4166106	268.47477	1330557.167	282129.6368	35062.421
6	3780	878.1303431	92.99792	356610.3347	927692.3222	34108.996
7	3780	900.6163018	266.654	1797163.024	1401758.787	35989.631
10	3780	833.6834847	270.98337	2026333.713	284245.053	35981.158
12	3780	874.4693193	288.77134	2316266.497	1160279.134	35979.219
13	3780	864.8818321	120.81885	67118.72084	778717.9174	30999.517
19	3780	794.4507406	144.72356	1283015.469	913246.5134	31312.82
22	3780	864.287613	273.60643	736449.9489	712422.0365	34017.541
23	3780	872.3128626	295.78792	152505.6873	1219162.58	35985.191
24	3780	764.757741	268.49985	1422741.585	284028.9782	29984.739
27	3780	757.983397	113.81014	2015165.304	523734.712	31007.724
28	3780	880.2169704	70.00229	1766082.602	949949.2752	40973.4
32	3780	810.4556165	165.08578	1619599.839	338242.9692	29000.003
34	3780	804.9692121	80.67189	2556989.972	1116975.343	35011.098
35	3780	790.3216591	109.23725	2666902.21	974486.6527	35000.026
36	3780	787.3998677	352.11958	1194030.553	521851.7575	31981.694
38	3780	795.3939953	69.99016	1703356.809	932871.3271	35025.076
46	3780	741.6658505	203.97235	682605.0243	772993.5831	25788.355
47	3780	707.0349308	210.52862	480210.3667	802198.2223	26001.035
1	3840	848.5458802	261.55734	27793.37747	1307817.99	29841.599
2	3840	862.1171011	97.75044	731975.3146	918473.4172	34118.304
3	3840	897.5103437	97.31479	1867302.531	801890.6787	35422.429
6	3840	879.5231384	89.86891	417744.1612	926864.4885	34258.281
7	3840	900.2659278	266.53194	1732743.028	1398947.446	36002.917
10	3840	832.7620936	270.87418	1969811.898	284945.1359	36024.497
12	3840	874.1659072	288.62645	2257929.499	1174876.08	36007.539
13	3840	865.0835119	109.02704	67118.72084	760822.4585	31001.239
19	3840	838.9926384	144.69048	1316149.813	878245.1763	32932.319
22	3840	864.8047521	273.47397	676329.719	715220.1267	34005.847
23	3840	872.1697458	295.65023	97085.6632	1238841.862	35998.99

24	3840	764.6291255	267.81203	1369479.032	282790.4266	29984.251
27	3840	758.3371174	114.9272	2063533.846	507043.2137	30990.616
28	3840	881.1540899	70.0972	1823703.666	965557.1915	40971.936
32	3840	810.2982215	158.40927	1634778.73	296227.726	28994.784
34	3840	805.258346	80.76555	2613093.849	1123766.876	34978.15
35	3840	790.3322563	109.35796	2719242.81	960821.6685	35000.024
36	3840	787.6016591	352.08552	1186492.902	563094.6295	31997.862
38	3840	796.4978798	69.98723	1755707.003	947114.0418	35001.779
46	3840	771.1514814	203.81081	660483.2674	735463.8315	27793.787
47	3840	743.1832456	210.48369	453948.6017	768696.6154	26005.935
2	3900	862.0898832	97.83197	792269.4159	912278.853	34211.48
3	3900	898.0685327	97.34048	1929127.23	795909.2015	35332.651
6	3900	877.7211829	89.19283	479062.3665	927382.5604	34129.831
7	3900	900.1365314	266.40827	1668903.148	1396059.738	36009.865
10	3900	834.2198102	270.76025	1913323.542	285560.4992	35984.552
12	3900	873.0996146	285.13849	2199320.927	1188817.398	36056.828
13	3900	864.2243649	107.92616	67118.72084	746440.5182	30999.979
16	3900	690.7859867	270.5454	2664063.748	395390.4089	30001.77
19	3900	844.4759194	144.73464	1350611.164	841764.8501	33000.566
22	3900	865.1351589	273.34905	616182.3565	717918.281	33990.891
24	3900	764.3595126	267.04761	1316239.085	280904.487	29989.318
27	3900	758.7031083	115.72102	2111864.841	489596.7984	30983.109
28	3900	879.5607302	70.21682	1881423.493	981085.6611	41019.43
32	3900	812.9748292	134.56907	1669367.737	261920.6818	29002.108
34	3900	804.1433066	80.86285	2669217.998	1130486.517	35015.312
35	3900	790.3176434	109.47896	2771511.431	947068.5358	35000.014
36	3900	786.7083782	352.06561	1178916.563	604339.9811	32020.155
38	3900	796.6162328	70.0711	1808053.169	961310.5273	34977.653
45	3900	855.2724814	277.17537	1453180.549	748490.0144	32000.035
46	3900	801.8553341	203.58599	637894.4176	696643.4824	29801.525
47	3900	791.1592773	234.52032	420894.6465	735273.6673	26004.214
2	3960	862.07092	97.7892	852879.3562	906067.8374	34298.571
3	3960	898.7975025	97.40759	1990885.692	789906.6576	35281.048
6	3960	882.6160453	89.73822	540504.2891	927837.8624	34082.388
7	3960	900.0614592	266.27984	1604859.176	1393058.494	36017.855

10	3960	832.8947248	270.65738	1856790.835	286094.471	36007.845
12	3960	877.2842472	277.79902	2138661.984	1197331.318	36052.306
13	3960	864.0232429	108.50065	67118.72084	732064.8818	31000.012
16	3960	702.691676	270.4754	2612855.299	395736.8506	30005.76
19	3960	845.5318381	144.79425	1384876.819	805362.3409	33000.046
20	3960	880.609956	268.17539	3158855.921	1435622.331	35980.511
22	3960	865.0659988	273.23191	556022.9417	720521.875	33981.829
27	3960	758.9516385	116.07253	2159535.164	471949.7065	30988.867
28	3960	880.0313536	70.34452	1939313.974	996542.7355	40982.537
32	3960	811.0286414	132.00368	1713144.271	230979.5592	28999.957
34	3960	805.3598552	80.9713	2725896.1	1137192.607	34998.54
35	3960	790.3087195	109.55482	2823741.91	933237.3039	35000.008
36	3960	786.6093231	352.05227	1171311.267	645588.3981	32006.347
38	3960	795.7043234	70.1833	1860456.801	975435.0912	34994.368
45	3960	855.2551914	277.05035	1393315.971	754111.9679	32000.025
46	3960	832.6709584	203.47345	614866.924	656694.1068	31783.945
47	3960	797.232204	253.41387	368050.195	718596.247	26001.759
2	4020	862.0760512	97.81058	913178.3711	899890.2965	33992.755
3	4020	898.7562295	97.51745	2052623.108	783828.1022	35209.384
6	4020	885.9699759	90.66914	603189.4881	927656.3371	34116.996
7	4020	900.2265511	266.13001	1540949.063	1389950.532	36020.168
10	4020	833.9687144	270.55333	1800022.677	286552.133	36002.205
12	4020	877.1136895	274.96498	2076880.163	1202138.63	36030.592
13	4020	864.0046143	108.99756	67118.72084	717174.9876	31000.026
14	4020	865.3863663	279.01065	2716768.622	267738.786	36010.158
16	4020	710.803822	270.39358	2563370.899	396022.7898	30020.281
19	4020	845.7977698	144.85635	1419211.081	768747.4382	33000.006
20	4020	880.4045951	268.29805	3095625.307	1434144.255	35988.957
22	4020	864.41634	273.11737	495294.1993	723056.9253	33995.989
27	4020	758.6709823	116.16976	2207083.739	454177.6116	31005.15
28	4020	881.2936371	70.46729	1997290.009	1011907.809	40961.457
32	4020	810.5972832	132.53836	1754980.004	201748.9195	29000.002
34	4020	804.8883394	81.07866	2782115.175	1143762.905	34986.561
35	4020	790.3252287	109.62395	2875926.941	919364.8803	35000.005
36	4020	787.1740934	352.0399	1163611.898	687209.9613	31987.824

38	4020	795.1907538	70.2964	1912983.22	989494.9569	35022.907
39	4020	744.2461918	189.08334	717019.9186	825759.9674	24097.113
45	4020	855.307173	276.98071	1333674.252	759632.3766	32000.033
46	4020	857.6695484	203.41966	591033.0597	615122.6024	32001.478
2	4080	862.0801785	97.89283	973452.8849	893675.6738	34048.429
3	4080	897.7702518	97.64032	2113813.722	777703.0481	35199.424
6	4080	890.0387096	94.70957	664971.4798	925656.9422	34321.493
7	4080	900.6055931	267.89442	1476997.58	1387585.929	36015.537
10	4080	862.006668	270.45259	1742511.055	286936.1062	36017.501
12	4080	874.9247721	274.43002	2015082.353	1205767.189	35978.111
13	4080	863.9487284	109.26457	67118.72084	702110.764	31000.001
14	4080	867.4291551	274.22577	2658386.432	272991.9246	36053.634
16	4080	722.0532711	270.34625	2512197.919	396272.4871	29996.594
19	4080	845.8657029	144.91634	1453300.063	732255.2999	32999.999
20	4080	879.1233483	268.78933	3033002.693	1432995.758	36022.412
22	4080	864.074109	272.99463	435106.5107	725474.1476	34011.984
27	4080	758.0658313	116.18579	2254594.17	436372.7577	31018.189
28	4080	880.4658353	70.57974	2055746.148	1027289.341	41002.366
32	4080	810.4493698	133.0566	1796487.488	172109.3337	29000.013
34	4080	804.2627751	81.18297	2838345.718	1150252.828	35024.412
35	4080	790.3135161	109.71845	2927953.982	905460.6663	34999.999
36	4080	774.7499264	352.02546	1155725.472	729697.5753	30420.153
38	4080	796.2047302	70.40397	1965542.773	1003469.871	35011.46
39	4080	742.4555028	204.17522	699701.4444	787248.571	24146.814
41	4080	729.2216047	271.91289	266410.3205	1169851.434	24100.342
45	4080	855.253072	276.85918	1273718.121	765106.5301	32000.015
46	4080	859.745021	203.38485	567151.8902	573315.2314	32000.099
2	4140	862.0927835	98.01127	1033950.546	887350.1258	34194.322
3	4140	897.7256324	97.76863	2175485.339	771423.2241	35224.59
6	4140	892.1978435	97.73403	726535.312	920419.7891	34199.999
7	4140	900.9800616	268.84992	1413056.884	1386361.205	36006.568
10	4140	873.5493783	270.33617	1683523.09	287246.6258	35981.766
12	4140	874.5919112	274.78549	1953553.267	1209412.532	36001.373
13	4140	863.9689187	111.88897	67118.72084	686551.1972	30999.966
14	4140	868.6595357	271.46601	2599659.763	275000.7059	36012.798

16	4140	734.2328122	270.26419	2460981.985	396481.0223	30012.214
19	4140	845.8741806	146.31218	1487223.049	695718.1877	32998.701
20	4140	879.1738798	269.17214	2970337.556	1432211.744	36000.319
22	4140	864.2651917	272.55188	374882.2708	727685.0069	34018.589
27	4140	757.7720124	116.21158	2302058.311	418559.1557	31015.708
28	4140	879.4679218	70.68938	2113780.568	1042454.499	41008.463
32	4140	810.4581821	133.31285	1837989.055	142038.821	29000.035
34	4140	805.5690087	81.29533	2894607.881	1156664.615	34987.197
36	4140	750.8384886	346.72778	1147179.344	771769.0992	28513.83
38	4140	796.7068103	70.50582	2018225.984	1017390.103	34980.811
39	4140	740.720588	208.17159	675011.8754	750940.2402	24052.21
41	4140	758.0591384	271.88817	211345.3773	1171215.111	26111.5
45	4140	855.2710313	276.72879	1214028.167	770452.9712	32000.019
47	4140	791.0881093	250.88195	203415.3837	679825.3355	26013.534
2	4200	862.0769436	98.12897	1094149.112	880958.8807	34138.129
3	4200	898.348408	97.89585	2237180.112	765035.2871	35179.493
6	4200	888.8663342	98.72337	788111.4158	913631.3216	35996.209
7	4200	901.2894973	268.98332	1349066.753	1385523.639	35995.719
10	4200	876.5319637	269.7269	1624162.562	287334.395	35996.975
12	4200	873.4727445	275.22449	1892127.073	1213406.711	36022.66
13	4200	867.0854739	118.99452	67118.72084	666089.0461	30884.019
14	4200	865.7732167	270.75992	2540430.909	275774.471	36006.202
16	4200	735.9166377	270.15022	2409416.222	396621.478	30003.329
19	4200	847.0124221	163.49236	1509543.341	654486.4643	33001.692
20	4200	880.1848444	269.30982	2907693.306	1431625.178	35980.224
22	4200	864.9440762	272.06857	314651.0951	729484.1438	34006.009
27	4200	757.300162	114.0195	2349559.385	400890.9733	31016.8
28	4200	880.8276988	70.80865	2171883.099	1057532.142	40961.038
32	4200	807.1453014	133.43757	1879005.864	112112.153	29007.375
34	4200	804.5221255	81.40756	2950901.682	1162995.352	35000.056
36	4200	730.2163948	313.53575	1118538.471	805984.5516	26908.483
38	4200	795.6560228	70.60438	2071382.225	1031349.608	34997.571
39	4200	736.2517296	206.8191	649981.6527	714979.5896	23984.437
41	4200	795.4265674	271.77198	154920.1232	1172545.74	27883.08
45	4200	855.5884985	285.49125	1154264.175	776618.0391	31997.558

47	4200	789.4108652	250.70022	149154.2374	665494.6931	26012.146
2	4260	862.0777244	98.2424	1154355.889	874472.4042	33721.308
3	4260	898.9372729	98.02535	2298808.316	758549.2209	35482.348
6	4260	889.0880928	98.56526	849280.7106	906630.5105	35400.954
7	4260	901.3307703	268.64596	1284536.204	1384558.84	35981.807
10	4260	876.5389913	268.94958	1564685.024	286760.2131	36018.851
11	4260	835.3178942	44.33983	879401.8913	512011.8246	27667.036
12	4260	873.7213862	275.48742	1830641.687	1217685.688	36000.713
13	4260	863.3163596	119.29274	67118.72084	643316.3106	29820.643
14	4260	864.7417271	270.94267	2481764.489	276422.3563	36010.938
16	4260	737.5878582	270.54328	2357740.071	396772.7679	29988.699
19	4260	846.1789313	165.63875	1524830.283	611201.6212	32999.985
20	4260	879.5895098	269.26512	2845098.131	1431063.459	36012.785
22	4260	864.9876917	271.92034	252800.2166	731031.9524	33983.461
27	4260	763.7221242	94.15417	2402533.047	392109.8466	31091.062
28	4260	881.1306647	70.94943	2230066.759	1072515.333	40981.364
32	4260	803.8478144	133.55807	1919587.428	82338.65209	28985.062
34	4260	805.1766924	81.52635	3007710.599	1169290.377	35010.664
36	4260	697.7129292	300.60104	1076299.191	828071.5592	25371.051
38	4260	795.3937722	70.7036	2124305.147	1045162.211	35024.677
39	4260	750.9037445	204.49814	626313.5399	677585.0237	24005.914
41	4260	805.2081491	271.64928	96121.22827	1173841.04	28001.01
45	4260	857.6030655	305.87686	1101589.941	798352.6594	32002.016
47	4260	789.2543625	251.01404	95424.82183	651428.0972	25999.655
50	4260	898.5599041	70.33498	1923667.476	992420.6762	35003.657
2	4320	862.0886562	98.35411	1214556.277	867894.4375	33689.385
3	4320	898.9210983	98.11744	2360610.187	751939.815	35508.498
6	4320	889.3957437	97.98221	910611.656	899979.5438	35411.554
7	4320	901.0833556	268.2577	1220623.484	1383255.735	35982.886
10	4320	876.3512551	268.48526	1505253.399	285701.7938	36016.28
11	4320	807.2739169	44.44632	921487.8189	544672.2415	25614.173
12	4320	874.5901264	275.54056	1769188.935	1222075.212	35979.419
13	4320	785.6176564	118.95403	67118.72084	621745.8624	27639.44
14	4320	865.9138794	271.30022	2423105.185	277317.3079	35979.408
16	4320	736.4772808	271.10044	2306080.793	397383.2701	30020.701

19	4320	845.9643118	165.46189	1539477.874	568007.6189	33000.001
20	4320	878.9169835	269.13213	2782460.615	1430421.194	36015.175
22	4320	864.4096471	272.35566	192492.7013	732766.7259	33999.793
27	4320	762.695989	86.06187	2456944.39	392937.1681	31115.133
28	4320	881.7425085	95.78386	2290981.267	1078944.797	41063.172
29	4320	897.7264132	90.79208	145986.511	18798329.71	40955.657
32	4320	802.385859	133.64958	1959991.647	52550.95255	29016.271
34	4320	805.2513184	81.59206	3064075.837	1175476.534	34980.89
36	4320	669.0683744	301.43317	1033305.434	846953.7585	23559.473
38	4320	796.3859966	70.80825	2176776.608	1058770.935	35007.72
39	4320	756.4368877	203.03275	604421.4062	639713.0031	24015.798
45	4320	855.9068581	308.17365	1053748.926	826243.1185	32000.001
50	4320	898.4694382	70.4435	1983173.281	1008204.7	35018.918
2	4380	862.0753819	98.46503	1274942.533	861204.7743	33650.851
3	4380	898.3284408	98.19407	2422135.065	745304.0038	35574.118
6	4380	888.2115442	97.80969	971960.4779	893641.6759	35328.849
7	4380	900.7424632	268.05636	1156714.793	1381738.035	35992.127
10	4380	876.8959467	268.48368	1445822.049	284497.4669	35993.982
11	4380	776.6746968	44.62488	961496.7887	575517.1213	23607.8
12	4380	874.5836566	275.46397	1707738.218	1226444.628	35998.277
13	4380	736.444374	128.95525	67118.72084	600728.8546	25434.732
14	4380	865.0955592	271.50007	2364427.638	278435.6385	36018.13
16	4380	737.3192493	271.21755	2254428.168	398205.2406	29984.168
19	4380	845.9048565	165.1951	1554435.282	524694.5436	33000.032
20	4380	879.6200741	268.96856	2719264.762	1429650.348	35988.612
26	4380	676.8116293	335.07631	2761392.821	821722.0223	24006.416
27	4380	758.8729967	86.32288	2509891.867	395988.885	31011.652
28	4380	884.2581517	111.06262	2350562.275	1066947.596	41069.209
29	4380	896.8887951	89.20414	210215.9309	18219418.87	40894.33
32	4380	802.3050979	124.87648	2001314.538	23688.72723	29023.466
34	4380	804.2561937	81.70344	3120448.855	1181590.883	35023.231
38	4380	796.545288	70.93573	2230167.907	1072523.32	34977.788
39	4380	757.5380951	202.9244	583082.5252	601306.6155	24013.8
45	4380	855.4756114	305.6765	1005329.826	853211.0209	32000.029
50	4380	899.0970104	70.5549	2042760.2	1023903.904	35009.937

18	4400	777.982269	208.49433	491105.68	647596.6657	26000.013
2	4440	862.0776129	98.57552	1335079.867	854451.8102	33601.338
3	4440	897.7435917	98.33585	2483618.376	738576.0222	35548.539
6	4440	889.5136505	97.87653	1033092.318	887350.2516	35285.309
7	4440	900.4131719	267.90956	1092827.857	1380081.146	36004.821
10	4440	877.5804087	268.19374	1386339.69	283244.3501	35979.842
12	4440	873.8986369	275.33332	1645728.807	1230762.946	36017.955
13	4440	701.9544516	140.44139	67118.72084	572099.3627	23240.261
14	4440	864.9521077	271.52245	2305764.296	279634.9853	36001.008
16	4440	737.4294593	271.10929	2202704.079	399011.3753	30006.817
19	4440	845.8971596	165.07549	1569486.517	481610.6568	33000.03
20	4440	880.2922657	268.81512	2656684.28	1428761.25	35987.073
26	4440	685.9928566	335.1101	2739735.005	856695.9871	23992.951
27	4440	760.5983183	89.98959	2562793.09	397069.3006	31088.286
28	4440	883.7102251	114.8401	2407170.047	1048425.274	41011.287
29	4440	896.4148253	88.81174	272130.5762	18076362.7	40895.125
32	4440	811.5822569	104.21753	2053079.152	7311.714168	29125.297
34	4440	805.6860232	81.83763	3176868.608	1187616.159	34988.044
38	4440	798.2905767	77.1802	2283785.999	1083784.465	35071.528
39	4440	758.015746	203.31093	561518.9369	563107.682	24001.94
45	4440	855.3298174	305.24712	955891.916	879494.1145	32000.017
50	4440	899.6149304	70.67008	2102463.683	1039525.814	34988.597
2	4500	862.0814055	98.687	1395210.332	847608.345	33458.499
3	4500	897.9304356	98.46588	2545105.51	731733.8276	35428.759
6	4500	888.6778172	98.02981	1094386.768	880939.1754	35221.83
7	4500	900.3141167	267.79001	1028358.11	1378301.071	36019.524
10	4500	877.7724953	267.2651	1326747.421	281374.486	35989.521
12	4500	873.498066	275.19198	1584144.918	1234938.737	36015.621
14	4500	865.9873899	271.41509	2246782.75	280799.1601	35981.45
16	4500	737.8845774	270.94955	2150815.542	399718.5224	30012.133
19	4500	845.8887935	165.04688	1584640.661	438358.4175	33000.017
20	4500	879.3851528	268.67446	2594121.061	1427754.799	36018.893
26	4500	687.0739852	335.13474	2718242.765	891406.3148	24018.056
27	4500	758.4892697	91.53209	2615853.635	396365.5387	30990.254
28	4500	882.4769442	113.33853	2463365.383	1029560.582	40986.482

29	4500	902.5718596	89.02902	334730.4652	18155575.87	41010.124
34	4500	804.3429785	81.96943	3233824.354	1193597.627	35010.372
38	4500	798.3973287	80.47593	2339189.179	1091603.067	35067.673
39	4500	758.4198865	203.43418	539708.3683	524839.5691	23991.281
45	4500	855.3133082	305.43678	906374.5838	905750.0589	32000.031
50	4500	899.289097	70.78986	2162247.255	1055056.642	34983.427
2	4560	862.0891024	98.80153	1455254.22	840682.1189	33388.553
3	4560	898.4855012	98.57087	2606535.161	724775.9868	35403.84
6	4560	888.7730796	98.2013	1155421.716	874416.2988	35117.468
7	4560	900.7459212	267.67815	964446.8121	1376443.018	36014.956
12	4560	874.0990897	275.05393	1522520.974	1239005.085	35991.04
14	4560	865.0619831	271.25172	2188140.15	281845.2338	36019.746
16	4560	746.2704635	270.80658	2098734.405	400322.745	29984.236
19	4560	845.9070874	165.05622	1599708.625	395293.1397	33000.011
20	4560	879.0583155	268.39444	2531444.323	1426600.57	36011.021
26	4560	688.3823383	335.12536	2697052.945	925587.3766	23995.756
27	4560	758.8183379	91.30106	2668684.293	395269.5675	30984.602
28	4560	882.9493524	110.93072	2520394.072	1012345.697	41038.717
29	4560	913.1059479	89.34686	398629.5229	18271449.9	41000.026
38	4560	796.7387132	81.37903	2394918.773	1098071.753	34997.447
39	4560	758.7635676	203.39757	517880.3068	486525.8906	23985.304
45	4560	855.2826324	305.40402	857095.351	931958.3059	32000.033
50	4560	903.3701011	70.97273	2221698.143	1070368.08	35007.755
51	4560	810.5310233	88.51118	1401694.773	1181543.794	35976.834
52	4560	802.8965283	109.57994	2833712.015	930614.5217	31018.445
53	4560	824.4589765	95.92752	834919.9206	852694.8602	37000.1
56	4560	881.2185649	90.7219	1454651.137	1094213.873	39000.033
59	4560	863.346924	96.09229	919597.4898	885839.3945	39026.036
2	4620	862.0982494	97.6281	1515264.094	833923.0792	33328.844
3	4620	899.0720235	98.48966	2667442.312	717903.0369	35389.592
6	4620	889.6451663	98.35373	1216666.058	867738.1391	35153.999
7	4620	901.2639527	267.56518	900580.6124	1374495.467	36001.625
12	4620	874.7565569	274.9273	1460968.907	1242962.528	35980.755
14	4620	865.0830657	271.15241	2129670.042	282769.017	35997.261
16	4620	748.5374649	270.69292	2045405.333	400852.0496	29991.646

19	4620	845.8371465	165.07795	1614798.172	352037.9597	32999.993
20	4620	879.9834993	268.01673	2468883.884	1425145.339	35981.379
26	4620	688.0005076	335.09308	2675796.082	959790.4916	23986.556
27	4620	759.0522553	91.30106	2721607.447	394681.3792	30983.735
28	4620	880.4869179	109.24869	2578745.964	996576.9736	41044.775
29	4620	912.4818337	89.56724	462466.5601	18351793.22	41000.017
38	4620	796.5593431	81.23445	2450521.466	1104348.169	34979.351
45	4620	855.3013725	305.28276	807474.8759	958225.6335	32000.024
50	4620	905.654504	101.68813	2284143.458	1074491.879	35006.088
51	4620	809.4600456	88.61352	1459271.553	1182610.267	36001.083
52	4620	803.0580506	109.63714	2887617.296	916265.9552	31018.167
53	4620	817.103576	96.01479	893144.3643	848132.371	36968.573
56	4620	881.2095295	90.83511	1516432.374	1093588.942	39000.024
59	4620	863.1319699	96.20738	979464.324	881006.6371	39029.349
60	4620	868.1138401	109.68703	2529382.793	1009389.549	35002.418
61	4620	867.8354149	294.30328	1148423.696	1760194.897	33983.302
2	4680	862.1032691	96.67801	1575559.373	828394.6198	33401.385
3	4680	899.03287	98.5315	2728881.048	710978.4894	35354.382
6	4680	888.312161	98.47758	1277736.425	860964.3757	35208.599
7	4680	901.5231916	267.44795	836720.6306	1372454.667	35987.333
12	4680	874.5711632	274.81097	1399403.109	1246823.807	36002.714
14	4680	866.0585579	271.06734	2070786.857	283645.3349	35983.571
16	4680	753.9274913	270.59676	1992684.028	401302.0477	30017.08
19	4680	845.8458473	165.10089	1629772.674	308967.6607	33000.025
20	4680	880.3530597	267.78262	2405762.611	1423440.276	35986.994
26	4680	687.2764459	335.05231	2654297.042	994271.9382	24016.461
28	4680	880.7197198	108.62195	2636903.915	981800.243	41014.733
29	4680	905.4866235	89.72533	526128.8358	18409427.65	40999.465
38	4680	795.3961147	80.93132	2506106.593	1110823.998	35014.208
45	4680	855.2902177	305.16471	757959.4633	984290.4981	32000.015
50	4680	900.5624238	110.03346	2344647.36	1060159.229	35001.302
51	4680	809.1433592	88.71827	1516344.797	1183589.395	36024.558
52	4680	803.4350848	109.73866	2941574.001	901830.1803	31012.317
53	4680	817.1323555	96.13118	949300.2126	843653.5546	36976.476
56	4680	881.2258156	90.94916	1578232.923	1092873.143	39000.023

59	4680	862.9753557	96.31981	1039298.044	876087.0288	39030.504
60	4680	867.6403165	108.74688	2587583.906	994399.9556	35009.896
56	4680	881.2258156	90.94916	1578218.711	1092873.143	39000.023
59	4680	862.9753557	96.31981	1039283.832	876087.0288	39030.504
60	4680	867.6403165	108.74688	2587569.694	994399.9556	35009.896
61	4680	867.3002049	294.19642	1091034.727	1778792.932	33998.08
2	4740	862.0984725	96.69851	1636009.118	823098.0631	33478.321
3	4740	898.6405537	98.65136	2790438.066	703965.1655	35351.298
6	4740	889.0671216	98.59752	1339167.417	854049.1063	35198.439
7	4740	901.3584344	267.32833	772870.0656	1370317.177	35981.391
12	4740	873.7573049	274.69483	1337792.988	1250593.678	36021.724
14	4740	865.0149096	270.95993	2012160.407	284439.0473	36021.269
16	4740	754.7448076	270.49122	1939737.253	401683.6826	30016.161
19	4740	849.3580652	137.56626	1658123.298	270453.0723	33004.241
20	4740	879.5803628	267.6384	2343226.362	1421604.381	36016.683
26	4740	688.2839525	335.00873	2632919.733	1028440.797	24002.918
28	4740	881.9276791	108.83211	2695073.268	967147.048	40983.223
29	4740	901.3129225	89.85957	589374.0107	18458367.15	40999.842
38	4740	796.1259769	80.75446	2561445.432	1117451.223	35016.984
45	4740	855.2875405	305.04507	708084.9685	1010401.932	32000.017
50	4740	900.0576666	110.51461	2404119.609	1043691.747	34981.166
51	4740	810.1165089	88.82685	1573418.32	1184489.501	36012.505
53	4740	817.6381167	96.26584	1005778.794	839054.3932	36978.736
56	4740	881.2278235	91.06377	1640295.34	1092062.276	39000.016
57	4740	836.1494887	348.61685	394588.7099	639783.6069	32024.743
59	4740	862.873735	96.42917	1099036.996	871085.4128	39028.518
60	4740	867.5109201	108.66996	2645394.066	979860.7749	35009.129
2	4800	862.0879869	96.85956	1696330.255	817714.0751	33502.381
6	4800	889.5490114	98.70928	1400052.733	847100.8127	35156.493
7	4800	900.6793267	267.20534	708443.3719	1368059.067	35999.005
12	4800	873.670297	274.5705	1276149.158	1254269.668	36010.491
14	4800	864.9623702	270.84208	1953203.636	285146.1994	36002.82
16	4800	762.0850375	293.57383	1888133.362	409318.4025	30077.902
19	4800	846.8343906	132.01269	1700206.265	239631.3223	33000.212
20	4800	879.1071738	267.52774	2280695.804	1419668.957	36014.413

26	4800	688.303585	334.96664	2611518.863	1062531.283	23983.946
28	4800	881.6156778	108.59464	2753174.8	952465.6412	41017.105
29	4800	900.0397073	89.93575	652366.1026	18486139.88	40999.965
38	4800	796.9109441	80.74158	2616790.889	1124139.289	34982.467
45	4800	855.6279867	298.81284	656840.9684	1034605.223	32000.547
50	4800	899.0652191	110.00339	2463483.716	1027388.101	34997.261
51	4800	810.8035364	88.93448	1630485.275	1185311.339	35984.501
53	4800	819.77271	115.18833	1060059.298	828460.9836	37081.18
56	4800	881.2183418	91.17722	1702053.732	1091164.018	39000.007
57	4800	837.233183	348.72339	382984.3323	683619.5496	32018.786
59	4800	862.8896864	96.53784	1158782.744	865996.039	39025.455
60	4800	867.4997653	109.09124	2703146.059	965139.6217	35009.647
2	4860	862.0918911	97.00743	1756555.109	812211.4885	35228.405
6	4860	888.3575612	98.82456	1461139.122	840034.0265	35185.382
7	4860	900.4208687	267.07571	644604.2656	1365716.558	36014.674
8	4860	658.2967993	273.29958	2034407.785	1369855.104	23771.609
12	4860	873.1833875	275.8123	1214472.996	1257991.885	36015.245
14	4860	866.0665894	270.72514	1894260.677	285761.522	35979.78
16	4860	762.2626228	309.49118	1843476.256	431658.3604	30113.757
19	4860	846.1136754	132.23799	1743489.211	209652.7105	32999.973
20	4860	879.861019	267.42492	2218183.742	1417651.065	35985.877
26	4860	695.2842939	334.92761	2589846.961	1096938.556	23514.495
28	4860	880.4243392	108.51305	2811840.424	937780.4859	41044.445
29	4860	899.6915642	86.46849	715292.4572	17222090.61	41000.024
38	4860	795.8503404	80.82665	2672340.222	1130816.618	34996.154
45	4860	855.3878226	296.499	602527.2503	1055389.467	32000.023
50	4860	898.6851731	109.40518	2523031.103	1011560.783	35018.317
51	4860	809.9157215	89.03937	1688086.306	1186062.138	35988.974
53	4860	823.3905644	130.36994	1107158.71	804408.5849	37041.21
56	4860	881.2176726	91.29164	1764103.726	1090170.021	38999.999
57	4860	838.0220544	348.71107	371466.0248	727177.7606	32011.11
59	4860	862.9723439	96.64681	1218529.706	860819.4745	39022.339
60	4860	867.5997128	109.4837	2760218.195	950211.3241	35004.149
2	4920	862.095126	97.13528	1816681.308	806607.654	35212.384
6	4920	888.6893067	111.29103	1521407.055	830469.0523	35211.603

7	4920	900.3462427	266.42492	580800.7439	1363209.985	36027.739
8	4920	684.3737292	273.23376	1984242.469	1371954.321	25782.653
12	4920	876.9780464	281.46047	1153195.45	1265286.83	36072.982
14	4920	865.4818518	270.61841	1835537.996	286286.9179	36013.691
16	4920	758.7773996	308.1944	1802463.585	458326.643	30088.556
19	4920	845.9129995	132.87557	1786113.231	179484.0973	33000.023
20	4920	880.4306975	267.31982	2155676.152	1415551.414	35985.836
28	4920	880.4458681	108.56093	2869968.256	923226.5394	41023.096
29	4920	899.5388542	86.10773	778326.2021	17090569.35	40999.988
38	4920	795.7100123	80.94633	2727982.867	1137423.196	35024.227
45	4920	855.3265825	296.28727	547984.8905	1075437.067	32000.013
50	4920	899.4783949	109.05886	2582705.497	996099.7439	35005.037
51	4920	809.2320403	89.14238	1745165.827	1186729.038	36018.268
53	4920	820.251811	136.62344	1148379.503	774823.3228	37073.62
56	4920	881.2139915	91.40636	1826044.822	1089085.856	38999.994
57	4920	836.55441	348.65946	359839.6947	770911.6131	31994.676
59	4920	863.0070355	96.75629	1278169.518	855565.131	39018.134
60	4920	867.5024425	109.70126	2818063.494	934806.4419	35011.454
2	4980	862.0856444	97.2559	1877117.811	800872.7004	35225.52
6	4980	896.664694	131.60019	1572600.4	804714.0954	35218.994
7	4980	903.1273714	263.48573	517120.3161	1358872.522	36095.359
8	4980	711.7523194	273.14433	1932726.389	1374056.652	27786.046
12	4980	877.1934467	283.79291	1092657.183	1275517.44	35992.618
14	4980	864.8928754	270.51283	1776937.598	286726.9035	36010.016
16	4980	758.9803064	302.64812	1758775.419	481595.3382	30076.8
19	4980	845.8891281	133.25147	1828511.111	148904.0338	33000.034
20	4980	880.0535518	267.21051	2092643.231	1413346.799	36006.295
28	4980	881.6246017	108.67237	2928017.33	908611.5231	40986.635
29	4980	899.4963542	86.24427	841190.6126	17140347.36	41000.008
38	4980	796.955452	81.07311	2783722.401	1143947.316	34988.03
45	4980	855.2947911	296.32603	493140.9201	1095557.028	32000.027
50	4980	899.7763411	109.01968	2642377.955	980776.9019	34982.538
51	4980	809.8406493	89.24996	1802267.415	1187317.812	36018.774
53	4980	821.2647835	142.16719	1184898.202	742276.8836	37040.851
56	4980	881.2168917	91.5199	1887811.503	1087913.3	39000.006

57	4980	829.9489504	348.60847	348259.1626	814186.6582	31987.034
59	4980	863.0680526	96.86762	1337875.619	850216.2386	39015.521
60	4980	867.5814188	109.64986	2874929.481	919623.1987	35006.903
2	5040	862.0834134	97.32102	1937231.271	795102.9143	34993.875
6	5040	894.5093528	138.8969	1615403.451	770909.359	35222.172
7	5040	902.1701732	261.9115	453076.9825	1352697.067	35985.742
8	5040	740.8870185	273.04663	1879576.61	1376161.197	29789.086
12	5040	875.0273968	284.09665	1032516.227	1286600.204	36002.033
14	5040	865.9747849	270.39763	1718174.129	287082.3437	35979.794
16	5040	757.4588956	301.58995	1713146.125	502888.0731	30017.508
19	5040	845.8955979	133.43913	1870496.066	118300.7853	33000.029
20	5040	879.1665176	267.09694	2030155.141	1411070.041	36022.287
28	5040	881.9977316	108.79731	2986012.335	893899.6521	41001.45
29	5040	899.4839724	86.41333	904039.7345	17201981.09	41000.034
38	5040	796.0920662	81.18804	2839369.641	1150370.559	34990.904
45	5040	855.2875405	296.31116	438264.0461	1115685.506	32000.03
50	5040	899.0268464	109.20211	2702036.1	965371.7863	34996.421
51	5040	810.7575784	89.35884	1859347.168	1187827.717	35988.746
53	5040	819.940479	144.30112	1218731.275	707804.3835	36993.852
56	5040	881.208414	91.6349	1949710.397	1086646.603	39000.017
57	5040	828.469705	348.56991	336666.3227	857255.7237	31984.468
59	5040	871.1076919	97.01583	1397608.19	844763.3717	39006.032
60	5040	867.5569897	109.68714	2932266.11	904307.4676	35009.612
2	5100	862.0867599	97.43574	1997394.965	789247.3055	34990.421
6	5100	890.0831059	139.06541	1655729.117	735604.0155	35118.118
7	5100	901.5280997	261.52175	389859.8441	1345877.87	35982.992
8	5100	771.4729643	272.94608	1824761.394	1378261.08	31778.749
12	5100	874.0983088	283.59613	972327.5205	1297513.835	36019.409
14	5100	865.8917928	270.29829	1659313.624	287344.8927	36003.209
16	5100	755.8640859	302.82584	1668091.899	524537.3506	29994.097
19	5100	845.8505323	133.52983	1912600.378	87427.35277	33000.134
20	5100	879.4480662	266.97743	1967691.945	1408700.739	36001.306
29	5100	899.4748254	86.5607	966907.4386	17255707.35	41000.028
38	5100	795.5903207	81.29571	2894990.864	1156706.872	35024.359
45	5100	855.3060576	296.23798	383553.704	1135693.283	32000.029

50	5100	898.734366	109.43723	2761534.989	949796.2925	35018.504
51	5100	810.0580574	89.46538	1916962.068	1188262.657	35986.775
53	5100	817.4680052	143.24109	1252025.938	673310.3673	36999.348
56	5100	877.4504546	91.72168	2011655.311	1085300.164	38987.038
57	5100	828.0675724	348.54223	325032.6692	900272.1851	31982.414
59	5100	876.0072393	97.11283	1457898.673	839158.8668	39000.285
2	5160	862.0868714	97.55163	2057387.035	783313.5732	34829.899
6	5160	888.2148906	136.89575	1697144.179	701027.9673	35109.598
7	5160	900.7881981	261.68867	326689.0684	1339022.621	36000.479
8	5160	795.7951239	272.8377	1767573.913	1380375.82	32001.453
12	5160	873.7155857	282.98486	911974.4999	1307957.267	36017.438
14	5160	867.837869	274.45026	1600435.832	289446.7096	36054.897
16	5160	756.4074389	303.19185	1623670.321	546511.0992	29982.585
19	5160	839.5865229	133.60406	1954238.413	56780.24607	33018.048
20	5160	880.2697329	266.85688	1905233.294	1406236.709	35979.999
29	5160	899.4633359	86.69098	1029782.65	17303203.17	41000.024
38	5160	796.8951042	81.41002	2950675.127	1162967.531	34994.394
45	5160	855.2586494	296.12542	328510.894	1155721.683	32000.012
50	5160	899.623185	109.62803	2820925.621	934041.3441	35000.617
51	5160	809.2938382	89.56997	1974065.593	1188614.82	36017.904
53	5160	817.058845	142.2102	1286218.658	639488.3098	37009.911
56	5160	869.5489123	91.84119	2072778.42	1083888.933	38986.265
57	5160	827.8879792	348.52032	313350.1166	943296.7122	31982.13
59	5160	878.5613667	119.40062	1516708.086	829209.072	39002.795
63	5160	853.3952307	255.40342	1564467.474	400418.4196	36015.673
65	5160	834.3748627	302.85636	1588303.708	564215.2771	25998.306

Traffic Level 3.0

Aircraft #	Time	velocity	heading	x	y	altitude
1	3000	848.5040495	282.59974	944438.9989	1315130.5	29472.395
3	3000	898.4644185	97.81991	1077466.904	890537.2204	35001.282
4	3000	847.613795	271.09675	2163209.72	283398.5596	34899.383

7	3000	900.6401732	268.75682	2705567.358	1428348.175	36004.597
10	3000	832.7829532	277.56715	2838147.136	263212.674	36049.804
13	3000	859.4410511	92.9662	142653.3747	880616.6649	31012.558
22	3000	864.8618649	274.72895	1594504.168	670330.8504	33980.531
23	3000	871.9827904	305.19156	924517.1057	935760.3647	36007.672
24	3000	763.4171504	271.14644	2191133.219	282962.5219	30013.801
27	3000	758.7324455	98.84064	1547552.632	838744.8785	30994.877
28	3000	890.0715049	53.46371	1104993.774	711103.7227	41005.978
33	3000	620.4243899	316.83045	792659.8763	837753.5586	18000.021
34	3000	721.9214207	78.44056	1913296.712	1018023.842	34410.93
35	3000	784.3158847	70.43666	2057854.405	1007907.092	34996.453
38	3000	721.4663026	19.09018	1181429.8	687057.1078	32285.329
48	3000	861.9951785	302.54463	1478161.434	654442.9609	30000.011
49	3000	891.633864	346.8435	1125005.436	614733.9676	36984.425
50	3000	898.4751272	53.02387	831225.7037	556881.3218	34986.452
51	3000	803.5092646	91.17946	0	1122719.837	36007.615
58	3000	902.1709541	97.18546	1627868.073	954359.5942	33000.011
64	3000	821.7155512	93.68272	1453539.814	1130242.302	30928.134
1	3060	848.5642857	282.35285	885218.9865	1324733.294	29448.28
3	3060	898.138139	97.93257	1139380.266	884131.5549	34410.93
4	3060	847.8606521	270.99196	2105152.125	284209.1332	34996.453
7	3060	900.5967808	268.60544	2641562.991	1427267.813	36006.462
10	3060	833.3807419	277.35643	2780725.347	269514.8569	35997.694
13	3060	858.7152046	93.27849	142653.3747	878120.6084	30994.5
22	3060	864.5379279	274.28388	1534550.852	673845.4576	33985.453
23	3060	870.9681447	305.54129	874977.1139	962068.2412	36021.842
24	3060	763.4555231	271.05523	2137956.65	283744.6014	30013.138
27	3060	760.3111923	117.12282	1599277.203	828503.3441	31052.671
28	3060	936.0185798	53.57152	1155803.641	739417.2064	41002.208
33	3060	620.4098886	316.64316	760731.5924	863166.4247	18000.023
34	3060	769.5118291	78.54627	1964492.137	1025774.029	35027.593
35	3060	783.9058322	70.5327	2109845.781	1021618.477	35023.509
38	3060	747.7083245	19.12476	1198212.475	723590.6695	34285.709
48	3060	861.9937284	302.46969	1426511.227	679279.6538	30000.005
49	3060	891.0988722	347.55373	1111432.346	660173.5189	36779.21

50	3060	898.9322532	53.15241	880809.085	585116.0265	34981.503
51	3060	801.8109377	91.27515	55930.00277	1121831.238	36027.866
58	3060	902.1606916	97.3247	1691277.284	948332.5929	33000.018
61	3060	867.2734333	262.21758	2732965.323	1372623.26	34006.134
64	3060	828.9329662	93.79328	1513083.889	1127359.65	31000.709
1	3120	848.6760573	282.23748	825399.4256	1334294.789	29501.393
2	3120	861.9488859	89.71427	75534.65171	929121.4287	33459.193
3	3120	897.1924303	98.10239	1201249.741	877601.9606	35134.683
4	3120	848.0048846	270.87631	2046912.303	284935.0703	34953.193
7	3120	900.569786	268.2081	2577578.215	1425959.752	36007.535
10	3120	835.585053	273.03904	2724467.716	273206.2686	36068.272
13	3120	858.9941876	93.63356	142653.3747	875273.3299	30984.123
22	3120	864.0366287	274.2483	1474014.98	677239.3737	33999.023
23	3120	870.9713796	305.43727	825331.8377	988478.658	36009.048
24	3120	763.5278066	270.9475	2084220.443	284461.0144	30017.528
27	3120	764.9963434	133.66676	1642305.351	803967.5634	31109.949
28	3120	949.6677732	54.82297	1208483.497	768543.414	40999.737
33	3120	620.4198164	316.54377	728631.3698	888569.9224	18000.02
34	3120	773.1237715	78.66421	2018246.164	1033830.985	34994.617
35	3120	785.057348	70.63219	2161998.263	1035289.984	35006.737
38	3120	793.0551566	19.82063	1215970.182	762062.5642	35002.444
48	3120	862.0033215	302.4054	1374824.85	704074.437	30000.009
49	3120	890.9340019	347.77255	1098410.68	705300.4643	35870.849
50	3120	898.8751403	53.23831	930550.8093	613302.422	34981.269
51	3120	805.8126308	91.39866	113014.9858	1120842.211	36014.151
58	3120	902.1426207	97.469	1754831.239	942169.8441	33000.021
61	3120	867.52676	262.09429	2671412.997	1366405.142	33996.749
62	3120	874.8503692	39.25718	317645.6768	822399.9114	34015.254
64	3120	830.1245279	93.90516	1572522.189	1124395.35	31000.063
1	3180	848.6578749	282.18214	766078.472	1343704.475	29561.393
2	3180	862.0112415	89.76837	136832.6199	929322.5585	33362.153
3	3180	898.017555	98.27674	1263067.609	870932.4673	34996.692
4	3180	848.1555868	270.76222	1988739.121	285570.5183	34884.372
7	3180	900.7835131	267.89825	2513031.026	1424335.602	36000.962
10	3180	834.0422249	271.22564	2667373.861	274651.761	35997.895

12	3180	874.2120883	289.81542	2973268.256	1009677.982	35990.429
13	3180	858.9753359	93.89728	142653.3747	872173.4655	30996.487
22	3180	863.8767796	274.3134	1414048.751	680630.4606	34007.128
23	3180	871.5992864	305.10825	775598.912	1014675.208	35986.916
24	3180	763.5297029	270.84216	2030990.976	285094.152	30017.875
27	3180	763.4619929	138.27954	1679566.949	774057.8302	31061.101
28	3180	920.4262106	67.95161	1266560.599	790471.1599	40998.61
30	3180	809.9906821	80.78351	2699434.839	1125068.044	35000.27
31	3180	653.3441548	165.8184	1250706.381	676950.6653	18711.542
32	3180	635.019292	121.36616	1500929.017	717909.144	21806.798
33	3180	620.4072115	316.47297	696500.4169	913898.0476	18000.011
34	3180	793.6564033	78.78609	2073595.977	1042031.17	35036.512
35	3180	785.3332075	70.73348	2214130.286	1048873.222	34978.964
38	3180	792.5078994	65.75914	1255537.566	788849.8299	35006.292
40	3180	861.989378	268.49793	1572751.348	285534.2332	33985.722
45	3180	855.2783935	278.47374	2243638.986	674431.5009	32000.018
48	3180	862.0018714	302.28554	1323230.026	728700.5451	30000.017
49	3180	856.8496931	337.81573	1082419.057	749311.1886	33950.632
50	3180	898.707929	53.31256	980356.9368	641412.2727	34986.188
51	3180	807.0740219	91.57379	169688.3625	1119757.732	36002.776
54	3180	827.5002365	283.13066	1111026.332	619709.3987	24000.049
58	3180	902.155895	97.53913	1818115.242	935934.8932	33000.033
60	3180	867.2318257	59.24886	1229864.045	778926.5897	35067.805
61	3180	867.6444438	261.97196	2609342.697	1360034.945	33983.241
62	3180	878.1480793	39.31801	356721.8775	858213.1309	33774.792
64	3180	830.4205778	94.01727	1632267.416	1121328.482	31000.017
66	3180	835.8666016	94.19191	1726948.628	1116295.191	26999.757
1	3240	848.6737148	282.14107	706727.3182	1353092.797	29648.482
2	3240	862.0295355	89.87832	197800.8122	929463.1953	335830.1
3	3240	898.6621941	98.42307	1324848.903	864135.546	35003.282
4	3240	848.3472274	270.65391	1930887.873	286116.6545	34223.84
7	3240	900.8138543	267.70521	2449069.132	1422528.529	36000.603
10	3240	833.2091802	270.95334	2610825.551	275410.3317	36020.367
12	3240	873.8030398	289.68691	2914267.234	1025439.031	36011.359
13	3240	858.1334789	94.36799	142653.3747	868929.8684	31013.214

17	3240	801.0276437	358.80651	400360.0111	566167.5346	34100.02
22	3240	863.7859791	274.33976	1354088.669	684060.1098	34014.607
23	3240	873.3719046	299.90008	724047.0841	1039139.383	36089.123
24	3240	763.6017633	270.7422	1977757.938	285654.3512	30018.339
27	3240	758.5448209	137.40709	1715534.879	743955.7964	30987.31
28	3240	892.592837	69.85609	1325357.606	807176.3353	40998.373
30	3240	810.2379852	80.88396	2756031.868	1131828.695	35019.623
31	3240	677.7200807	167.72825	1261726.259	640799.2565	20713.657
32	3240	677.0513471	121.19575	1541736.803	699264.632	26227.102
33	3240	620.4151314	316.41057	664305.3663	939191.4591	18000.009
34	3240	803.4551635	78.89918	2128876.482	1050131.83	35000.224
35	3240	786.4349727	70.85735	2266131.606	1062335.191	35010.729
38	3240	788.887814	71.14581	1307143.347	803151.5135	35000.045
40	3240	861.6334265	268.4843	1513701.674	284343.5981	33996.853
45	3240	855.29111	278.36349	2184107.444	681081.4786	32000.021
48	3240	861.9794502	302.16344	1271396.527	753300.5104	30000.015
49	3240	830.3529867	326.66115	1053846.947	788056.6155	32404.092
50	3240	898.3778568	53.3904	1030275.586	669475.0071	34994.972
51	3240	809.6383002	91.81266	226464.3586	1118508.519	35989.555
54	3240	827.7267916	283.02438	1052595.884	629976.7474	24000.011
56	3240	952.6226945	91.10553	141423.1513	1059380.115	39000.517
58	3240	902.1738543	97.64614	1881421.071	929632.1931	33000.037
60	3240	871.4383218	67.80988	1284483.691	798567.3535	35062.262
61	3240	867.3773965	261.8439	2547822.429	1353620.197	33982.008
62	3240	871.0876132	46.31585	397176.3558	893029.2863	32605.092
64	3240	829.7165948	94.09988	1692030.963	1118185.705	30972.481
66	3240	834.5745346	94.30481	1787682.428	1112949.918	26999.965
1	3300	847.2058473	277.67594	647197.9665	1361852.367	29454.383
2	3300	862.0406903	90.00327	258755.114	929507.4031	33848.954
3	3300	897.810744	98.54468	1386680.455	857220.8852	35129.032
4	3300	848.4269846	270.5473	1872779.722	286581.9538	34580.4
7	3300	900.8738674	267.57364	2385099.087	1420593.727	35999.753
10	3300	834.0235962	271.2187	2554372.803	276225.4488	35978.6
12	3300	873.1498114	289.5678	2856569.846	1040736.007	36012.656
13	3300	862.66592	95.64421	142653.3747	864778.7098	31000.19

17	3300	803.1264299	358.79974	399190.1773	608579.1304	33681.309
22	3300	863.8418649	274.29758	1294097.785	687481.3567	34019.432
23	3300	874.9071474	296.39061	669883.1745	1060306.745	36049.153
24	3300	763.7023801	270.64564	1924396.481	286146.0412	30018.296
27	3300	758.9993812	135.43983	1752488.051	714772.5328	30984.577
28	3300	881.4853891	69.76319	1383115.308	823084.3007	40999.42
30	3300	811.1138645	80.99406	2812542.026	1138498.896	34979.338
31	3300	708.6671093	200.35619	1259982.709	603382.4676	22723.54
32	3300	756.5079442	154.3281	1576173.582	673557.8772	28996.901
33	3300	620.4056498	316.35002	631966.4883	964515.7289	18000.002
34	3300	804.4189431	79.01105	2184394.56	1058181.547	34979.335
35	3300	793.1516461	79.14781	2319035.283	1075442.256	34994.121
38	3300	784.5531485	70.6663	1359423.746	816703.6299	35015.141
40	3300	861.3452966	268.45629	1454646.595	283121.3662	34010.004
45	3300	855.2686888	278.25512	2124812.005	687616.4581	32000.019
48	3300	862.0221733	304.01697	1219544.104	778223.4326	30000.097
49	3300	806.0330588	322.69172	1019966.664	823092.1875	30789.806
50	3300	898.169261	53.47675	1080340.037	697501.8702	35005.905
51	3300	810.1255443	91.99782	283322.2991	1117101.599	35977.794
52	3300	714.9249835	78.01079	1744663.041	991805.3709	26618.811
54	3300	827.7851315	282.91842	994154.1829	640155.4674	24000.004
56	3300	950.6948008	91.28374	208225.0253	1058341.605	38999.958
58	3300	902.1389396	97.77017	1944629.574	923237.2836	32999.998
60	3300	870.5297588	70.86335	1341435.607	814325.5914	35043.045
61	3300	870.8381906	276.78837	2484984.371	1350877.87	34081.962
62	3300	849.2690495	64.4633	447869.1728	918004.4939	31098.467
64	3300	826.4140881	94.20782	1751188.234	1114999.895	30999.79
66	3300	834.2628679	94.41813	1848618.503	1109502.598	27000.01
1	3360	852.7368711	264.85316	585851.3436	1361941.274	29876.77
2	3360	862.0470486	90.125	319959.5961	929453.867	34002.228
3	3360	897.4114001	98.65704	1448440.33	850214.8747	35382.902
4	3360	848.4117025	270.43835	1814279.899	286965.9587	34430.32
7	3360	901.0253504	267.46485	2320575.181	1418545.626	35990.948
10	3360	832.6961684	271.46921	2497872.814	277256.6417	36010.955
12	3360	874.2647393	289.45168	2798797.903	1055944.549	35979.051

13	3360	863.6201064	95.86362	142653.3747	860132.6416	31000.044
17	3360	792.1105634	358.79676	398017.0047	650885.0996	31949.82
19	3360	606.6770338	101.10307	1076109.731	1046576.135	17278.049
22	3360	864.410651	274.20143	1233553.38	690874.4862	34012.667
23	3360	872.7016093	295.36093	614353.7083	1080149.479	35981.351
24	3360	763.8306609	270.55063	1871160.371	286568.5978	30017.538
27	3360	758.6132001	134.18445	1790506.11	686399.4024	31004.469
28	3360	873.541793	69.61061	1440141.291	838931.552	41009.692
30	3360	809.8493501	81.09874	2869039.154	1145085.033	35007.622
31	3360	732.549656	209.46576	1236518.138	568143.9077	24733.408
32	3360	799.9652553	165.37127	1593514.274	633214.0265	29002.172
33	3360	620.4010763	316.29047	599613.9034	989770.4962	18000.004
34	3360	803.7592449	79.1184	2240037.718	1066163.753	35013.104
35	3360	798.3170137	106.90364	2374136.672	1069731.661	35003.463
38	3360	779.8277284	69.90164	1411458.455	830724.9777	35002.65
40	3360	861.413899	268.4707	1395694.33	281915.9076	34018.516
45	3360	855.2454867	278.14344	2065220.672	694093.9548	32000.015
48	3360	862.0134725	305.89294	1169370.928	804876.4016	30000.012
49	3360	775.7404318	322.68348	985644.0691	856633.8574	28829.988
50	3360	898.0816954	53.57285	1130544.82	725479.8843	35015.968
51	3360	809.7674734	92.13487	340685.9293	1115564.726	35983.046
52	3360	743.8499713	78.12447	1796349.425	999939.222	28620.504
54	3360	827.7991866	282.81216	935416.6887	650294.8403	24000.002
56	3360	951.2198598	91.44641	275101.2408	1057152.673	39000.047
58	3360	902.1348123	97.89197	2007788.096	916742.3023	32999.994
60	3360	867.7354674	71.20801	1398840.535	828989.4873	34994.494
61	3360	875.0614191	292.54401	2425081.81	1363873.489	34104.617
62	3360	824.3171983	68.04239	503411.8618	934590.7812	29352.538
64	3360	828.5114242	94.32943	1810991.547	1111686.677	31018.462
1	3420	851.878728	259.6634	525519.6321	1355380.947	28763.118
2	3420	862.0519567	90.24914	380941.456	929299.3958	34122.98
3	3420	898.3201862	98.77571	1510120.432	843122.1248	35763.983
4	3420	848.448402	270.3215	1756221.285	287260.285	34883.28
7	3420	901.0605997	267.36042	2256637.878	1416430.308	35988.59
10	3420	833.5940227	271.56765	2441397.208	278420.032	36008.73

12	3420	874.0468849	289.3438	2740983.595	1071060.469	36006.881
13	3420	863.8737678	95.92507	142653.3747	855384.1376	31000.012
17	3420	758.5852014	358.79392	396869.7036	692093.3349	29950.076
19	3420	630.0145543	101.10341	1121860.71	1039903.482	19280.506
22	3420	864.8018518	274.08054	1173529.363	694150.1236	34002.571
23	3420	872.1395161	295.50005	559069.5963	1099609.136	36000.674
24	3420	763.9625113	270.4538	1817933.874	286922.9065	30015.936
27	3420	757.7996765	133.77598	1828992.434	658427.7357	31019.762
28	3420	871.1008875	69.52264	1498350.729	855196.2759	41004.486
30	3420	810.572854	81.20664	2925642.423	1151601.782	35013.43
31	3420	760.6412645	209.69426	1209845.078	532755.6309	26744.393
32	3420	808.1120928	165.93937	1607438.817	591219.3967	29000.386
33	3420	620.3894752	316.23059	567229.5542	1014970.2	18000.006
34	3420	804.8803079	79.24427	2296240.028	1074136.021	35008.499
35	3420	795.307322	109.71352	2427221.155	1056176.348	34999.769
38	3420	788.525058	69.46478	1463074.701	845088.4973	34987.067
43	3420	876.158053	103.85592	229893.2225	1442141.854	34980.325
45	3420	855.2778358	278.02568	2005869.414	700452.768	32000.029
48	3420	862.0026523	305.89015	1119555.194	832018.2142	30000.005
49	3420	744.8005941	323.86858	953006.8213	889413.3071	26836.927
50	3420	898.2124303	53.68441	1180834.188	753365.9357	35020.288
51	3420	810.313169	85.10173	397521.8523	1116013.95	36081.098
52	3420	773.9230169	78.23679	1849806.939	1008267.666	30625.281
54	3420	827.8020869	282.70632	876854.7771	660313.5004	24000.006
56	3420	951.2147286	91.59874	341734.9083	1055833.973	38999.997
58	3420	902.1401667	98.01083	2071020.802	910136.8229	33000.002
60	3420	867.9933677	70.54484	1456084.678	843871.4741	34983.082
61	3420	872.9416618	297.4759	2368765.985	1383852.777	34078.622
62	3420	793.5921514	57.64195	555368.2899	953752.8036	27745.956
64	3420	829.7905515	94.45157	1870309.696	1108305.775	31000.657
1	3480	849.061123	259.23113	465683.6709	1346985.659	28845.98
2	3480	862.0809593	90.3056	441847.4351	929086.706	33928.421
3	3480	898.7127256	98.71594	1571808.863	835936.2299	35485.119
4	3480	848.4757314	269.68185	1698167.427	287320.2884	35001.28
6	3480	878.1044638	97.6896	127424.3333	957533.7823	33802.941

7	3480	901.118828	267.2511	2192715.242	1414227.932	35986.21
10	3480	833.6741146	271.52031	2384922.56	279594.5666	35980.314
12	3480	873.1292865	289.23723	2683084.032	1086097.677	36017.33
13	3480	863.9514056	95.99793	142653.3747	850597.8812	31000.013
17	3480	727.2486453	358.82195	395773.5419	731907.0352	27950.84
19	3480	654.2820551	101.17319	1168960.483	1033009.108	21281.586
22	3480	865.0159135	273.95038	1113502.396	697325.5621	33991.685
23	3480	871.2930856	295.92007	504160.4906	1119222.332	36019.801
24	3480	764.1663105	270.35071	1764618.422	287206.8149	30012.197
27	3480	757.6487513	133.87902	1867852.564	630247.3977	31013.615
28	3480	874.1772852	69.52578	1555057.729	871065.4929	40961.632
30	3480	810.4785955	81.32123	2983332.13	1158156.93	34987.151
31	3480	794.8538771	209.21027	1182639.21	496097.5795	27991.778
32	3480	809.9093632	165.4585	1621668.003	548932.6928	29000.089
33	3480	620.3980645	316.17002	534706.3751	1040196.815	18000.011
34	3480	805.1312922	79.79153	2352014.376	1081815.315	34977.781
35	3480	791.4366986	109.40269	2479766.351	1042274.684	34999.817
38	3480	791.7230437	69.36758	1515666.386	859909.538	34990.458
43	3480	884.3029942	104.2403	291197.2123	1430932.331	34710.637
44	3480	667.7075935	273.29583	444418.0658	1167385.075	21264.565
45	3480	855.2944565	277.92076	1946226.065	706745.6242	32000.034
48	3480	862.0033215	305.62007	1069627.535	858945.8408	30000.014
49	3480	714.5476787	324.92567	921981.5406	921907.4249	24816.723
50	3480	900.2180734	59.79641	1232301.496	780049.2768	35052.955
51	3480	812.3724669	78.92535	453945.4412	1122382.992	36035.852
52	3480	800.2466923	78.40311	1905569.246	1016854.153	31001.964
54	3480	827.8046525	282.59977	818016.9092	670288.6321	24000.01
55	3480	807.0041925	280.09244	2768792.548	611720.3969	32002.289
56	3480	951.5429045	83.42857	408458.7535	1057637.584	39000.687
58	3480	902.1663806	98.12895	2134374.375	903417.1349	33000.013
60	3480	868.1494241	69.88401	1513386.736	859355.7163	34980.218
1	3540	848.3165363	260.73002	405346.0233	1339152.471	28764.22
2	3540	862.1009265	90.42566	503055.1645	928793.2437	34002.123
3	3540	897.9080143	97.19572	1633690.657	829561.1553	35185.403
4	3540	848.3386381	268.9062	1638604.094	286715.4277	35183.28

6	3540	877.4642866	97.82646	189619.788	951208.4738	33890.2
7	3540	901.1338871	267.13623	2128803.318	1411934.103	35983.987
9	3540	663.6844832	1.36958	3100596.03	1102689.34	20339.392
10	3540	832.6168574	271.4032	2328443.75	280699.9892	36023.371
12	3540	874.095297	289.12355	2625032.898	1101072.15	35983.11
13	3540	863.9211759	96.09488	142653.3747	845750.6996	31000.007
17	3540	697.7169449	358.82456	394722.1731	770469.4286	25948.994
19	3540	679.4334666	101.26308	1217423.978	1025858.821	23281.581
22	3540	865.0222718	273.80664	1053412.541	700397.1007	33982.952
23	3540	870.9792995	296.2161	448856.0481	1139290.209	36019.939
24	3540	764.4175179	269.87389	1711317.277	287345.9534	30007.445
27	3540	758.1087775	134.15189	1906177.224	602211.2853	30993.638
28	3540	872.918125	69.60022	1612083.236	886975.3296	41020.12
30	3540	809.9041204	81.43544	3039958.088	1164504.033	35024.557
32	3540	810.3358133	165.16837	1636239.945	506776.6926	29000.024
33	3540	620.4024149	316.10935	502042.2639	1065451.796	18000.017
34	3540	803.9765415	80.2019	2407911.202	1089105.897	35009.775
35	3540	790.5647235	109.09809	2532301.224	1028652.309	34999.985
38	3540	792.556423	69.45194	1568399.844	874752.252	35025.16
43	3540	871.6372129	104.53289	352704.5527	1419353.101	33312.199
44	3540	692.84495	271.47453	393706.1996	1168680.009	23266.657
45	3540	855.2685772	277.77924	1886542.514	712952.4024	32000.024
47	3540	614.9263845	210.19908	654763.9166	928254.2494	20033.432
48	3540	861.9888202	305.46327	1019370.09	885823.6867	30000.013
50	3540	902.6886509	67.67663	1288974.213	800358.4777	35077.633
51	3540	810.7617057	77.38178	509787.6812	1131290.522	36013.745
52	3540	804.0142449	78.56626	1961866.866	1025381.755	31000.498
54	3540	827.8026446	282.49374	759394.5033	680136.876	24000.011
55	3540	813.2347373	281.68115	2711778.027	620043.7269	31993.05
56	3540	951.4460803	80.95312	474367.482	1064766.113	38999.999
58	3540	902.1421745	98.24746	2197387.1	896632.5381	33000.018
1	3600	847.9430718	262.28227	345285.3081	1332714.434	29003.8
2	3600	862.0628885	90.54662	563993.0951	928404.4468	34113.39
3	3600	897.6261311	96.5413	1695143.706	824086.7503	35211.353
4	3600	848.4123718	268.50827	1580574.489	285677.9863	35099.375

6	3600	876.6671606	97.95565	250698.7597	944885.2491	33909.395
7	3600	900.9969055	267.01522	2064329.099	1409522.57	35980.665
9	3600	640.8294103	0.83792	3101357.524	1140055.686	18301.475
10	3600	834.0936487	271.24993	2271919.999	281701.8938	35990.194
12	3600	874.3917931	289.00508	2566958.976	1115946.182	35995.799
13	3600	863.9547521	96.20947	142653.3747	840797.7893	31000.015
17	3600	669.5714584	358.82226	393703.9743	807731.4898	23949.375
19	3600	710.5590844	131.82357	1263949.879	1011677.579	25293.747
22	3600	864.5543256	273.85296	992794.2513	703446.1305	33987.835
23	3600	871.1325672	296.26052	393794.8628	1159393.33	36006.078
24	3600	764.6021308	269.06275	1658014.77	286920.2407	30001.373
27	3600	759.3175177	124.59618	1946509.357	575935.0926	31085.351
28	3600	877.6396409	69.71762	1668685.814	902673.3939	40968.308
30	3600	811.2624472	81.53729	3096527.832	1170753.116	34987.606
32	3600	810.4340876	165.06464	1650968.278	464643.374	29000.007
33	3600	620.4010763	316.0475	469403.3955	1090605.792	18000.02
34	3600	804.658884	80.41394	2463884.546	1096180.816	35016.309
35	3600	790.3772103	109.02039	2585124.559	1015085.711	35000.024
38	3600	796.0889428	69.60253	1621710.87	889647.7674	34993.725
43	3600	839.0139442	104.66383	413086.0479	1407846.692	31302.574
44	3600	720.0749574	271.9279	341313.8866	1169871.854	25274.453
45	3600	855.263446	277.74738	1827105.499	719062.5041	32000.016
46	3600	686.6707372	185.19828	793918.1962	846461.6003	21768.471
47	3600	639.1583013	210.3843	631257.3691	898091.5528	22042.597
48	3600	862.0016483	305.45629	969147.5237	912579.2644	30000.016
50	3600	902.0125551	70.69425	1347942.066	816806.9217	35059.38
51	3600	809.0401768	77.95279	565438.8127	1140351.24	36025.296
52	3600	810.3330246	78.69015	2018689.915	1033878.853	31000.318
54	3600	827.7994097	282.38612	700465.6174	689945.618	24000.013
55	3600	816.4781232	282.42037	2655579.252	629197.2991	31988.071
56	3600	913.5898455	81.07912	539653.2297	1072489.954	38996.757
1	3660	847.7565626	262.38292	285141.0156	1326811.162	29046.764
2	3660	862.0856444	90.6678	624963.3872	927919.1134	34122.184
3	3660	898.4422204	96.50734	1757172.658	818795.73	35231.988
4	3660	848.4674768	268.49942	1522556.917	284518.6151	35004.51

6	3660	877.205717	98.08121	311105.8636	938528.3165	34015.499
7	3660	900.9067742	266.89523	2000433.348	1407032.885	35981.909
10	3660	833.038734	271.16087	2215339.168	282600.7748	35999.134
12	3660	873.4585778	288.86222	2508301.742	1130848.82	36021.421
13	3660	866.8514451	113.89488	142653.3747	831979.8138	31002.573
17	3660	642.4359326	358.81969	392711.6119	843913.0983	21943.647
19	3660	736.4143674	146.69554	1295959.556	980580.0528	27308.609
22	3660	864.1736103	273.83454	932701.5185	706497.5388	34000.254
23	3660	871.6121145	296.11089	338607.5835	1179454.609	35990.583
24	3660	764.742905	268.65302	1604797.703	286071.8585	29995.563
27	3660	761.6916057	115.66753	1993161.239	556313.5373	31088.362
28	3660	880.2930465	69.8542	1726512.501	918591.4803	40974.717
30	3660	810.1174013	81.61552	3153332.217	1176973.064	35000.414
32	3660	810.4427884	165.04823	1665737.748	422471.8309	29000.003
33	3660	620.4011878	315.9841	436693.2022	1115732.336	18000.022
34	3660	805.1868434	80.52035	2520396.088	1103212.001	34977.952
35	3660	790.3290214	109.06014	2637553.667	1001618.951	35000.032
38	3660	796.0742184	69.74217	1674274.204	904210.2824	34980.199
43	3660	806.2773421	104.77549	471085.2177	1396693.789	29307.734
44	3660	748.8550436	271.88364	287441.2893	1171206.854	27276.882
45	3660	855.2590956	277.63722	1767374.308	725142.6741	32000.016
47	3660	664.2268323	210.57751	606947.1212	867222.3361	24042.717
48	3660	862.021504	305.35401	918764.0492	939336.6076	30000.014
50	3660	899.4850878	71.19445	1407369.626	832065.6828	35006.878
51	3660	809.8212398	79.06021	621795.7537	1148795.937	36014.988
52	3660	811.8123816	78.8021	2075645.48	1042303.179	31000.077
54	3660	827.7884779	282.27777	641702.9734	699635.1251	24000.011
55	3660	817.1774212	282.51008	2599807.168	638551.9142	31988.534
56	3660	890.8890443	81.5023	602065.9976	1079578.293	38999.005
58	3660	902.2046417	100.30518	2323428.084	882061.2339	33000.05
60	3660	867.7573309	69.65271	1684039.214	906871.3528	35011.624
1	3720	847.6280586	262.04557	225035.2612	1320777.523	29134.554
2	3720	862.0887677	90.79808	686109.675	927333.4682	342004.382
3	3720	898.7913673	96.75672	1819093.496	813394.991	35359.021
4	3720	848.506965	268.44415	1464574.62	283327.3835	35144.3

6	3720	876.0595556	98.20933	371462.0249	932074.421	33993.012
7	3720	900.7744776	266.77508	1936564.616	1404445.427	35984.791
10	3720	833.6260372	271.08996	2158332.362	283462.0424	36009.895
12	3720	873.4904807	288.86543	2450032.255	1145595.394	36003.467
13	3720	865.6934595	127.79352	142653.3747	806792.3593	31001.451
17	3720	617.0010762	6.68058	392218.66	878808.3338	19932.909
19	3720	764.7163565	145.07384	1326492.406	947246.9378	29311.023
22	3720	863.9720421	273.7363	872620.1803	709494.0039	34012.769
23	3720	872.0585318	295.94056	283317.9559	1199390.579	35980.989
24	3720	764.834598	268.57832	1551482.903	285066.9902	29988.784
27	3720	760.4869928	113.32077	2041949.115	539809.9447	31027.09
28	3720	879.155809	69.99073	1783988.243	934278.0562	41020.649
32	3720	810.4518238	165.06297	1680466.368	380336.3579	29000.003
33	3720	620.4082154	315.91573	403859.2508	1140868.776	18000.02
34	3720	804.0606491	80.59228	2576453.964	1110121.904	35013.08
35	3720	790.3235555	109.14186	2689922.216	988110.0272	35000.032
36	3720	787.3658454	352.1719	1277307.494	479179.3468	31982.139
38	3720	795.4391724	69.8629	1726179.254	918481.9165	35001.286
43	3720	774.7781482	104.87715	527242.7114	1385808.566	27314.975
44	3720	778.9370131	271.76789	231882.763	1172514.775	29278.675
45	3720	855.266904	277.51756	1707888.088	731102.2461	32000.022
46	3720	714.3570898	202.0303	779229.0895	809518.6742	23783.685
47	3720	698.0239265	210.57221	581873.6725	835422.6074	25866.202
48	3720	862.011353	305.23696	868216.4721	966037.1499	30000.01
50	3720	899.4847532	70.70249	1466678.869	847412.891	34993.269
51	3720	810.402854	79.91238	677850.6269	1156456.346	35995.672
52	3720	812.164652	78.91071	2132733.087	1050659.39	31000.02
54	3720	827.7618178	282.1672	582851.595	709246.5707	24000.015
55	3720	817.3719619	282.3399	2543979.03	647855.8737	31989.011
1	3780	847.7561164	261.74866	164407.6874	1314416.425	29259.448
2	3780	862.2369042	96.36446	746856.2184	924290.3173	34120.375
3	3780	898.049681	97.05021	1880987.038	807757.8294	35238.5
4	3780	848.4166106	268.47477	1406091.821	282129.6368	35062.421
6	3780	878.1303431	92.99792	432144.9886	927692.3222	34108.996
7	3780	900.6163018	266.654	1872697.678	1401758.787	35989.631

10	3780	833.6834847	270.98337	2101868.367	284245.053	35981.158
12	3780	874.4693193	288.77134	2391801.151	1160279.134	35979.219
13	3780	864.8818321	120.81885	142653.3747	778717.9174	30999.517
17	3780	599.8806032	60.91376	421023.5738	903435.3028	17953.065
19	3780	794.4507406	144.72356	1358550.123	913246.5134	31312.82
22	3780	864.287613	273.60643	811984.6027	712422.0365	34017.541
23	3780	872.3128626	295.78792	228040.3411	1219162.58	35985.191
24	3780	764.757741	268.49985	1498276.239	284028.9782	29984.739
27	3780	757.983397	113.81014	2090699.958	523734.712	31007.724
28	3780	880.2169704	70.00229	1841617.256	949949.2752	40973.4
32	3780	810.4556165	165.08578	1695134.492	338242.9692	29000.003
33	3780	620.7595934	308.93874	370225.9868	1165280.6	18000.834
34	3780	804.9692121	80.67189	2632524.626	1116975.343	35011.098
35	3780	790.3216591	109.23725	2742436.864	974486.6527	35000.026
36	3780	787.3998677	352.11958	1269565.207	521851.7575	31981.694
38	3780	795.3939953	69.99016	1778891.463	932871.3271	35025.076
43	3780	743.3270317	104.97882	581580.1696	1375195.462	25334.409
44	3780	808.8363776	271.65212	174528.6768	1173778.387	31282.259
45	3780	855.280736	277.40172	1648100.8	736996.3873	32000.031
46	3780	741.6658505	203.97235	758139.6781	772993.5831	25788.355
47	3780	707.0349308	210.52862	555745.0206	802198.2223	26001.035
48	3780	862.0143649	305.12551	817540.4067	992662.3024	30000.006
50	3780	899.4138083	70.12134	1525847.768	863219.054	34981.805
51	3780	811.1188842	85.07578	734430.2752	1161693.485	36072.436
52	3780	812.2440745	79.01908	2189934.968	1058945.893	31000.007
53	3780	862.881878	105.46698	167044.7031	909542.7126	37000.03
54	3780	827.7967325	282.04893	523990.8309	718763.5054	24000.02
55	3780	817.4639894	282.12259	2488075.909	657009.0731	31988.954
56	3780	881.9938274	83.64352	724995.2411	1092627.512	38999.736
1	3840	848.5458802	261.55734	103328.0313	1307817.99	29841.599
2	3840	862.1171011	97.75044	807509.9684	918473.4172	34118.304
3	3840	897.5103437	97.31479	1942837.185	801890.6787	35422.429
6	3840	879.5231384	89.86891	493278.8151	926864.4885	34258.281
7	3840	900.2659278	266.53194	1808277.682	1398947.446	36002.917
10	3840	832.7620936	270.87418	2045346.552	284945.1359	36024.497

12	3840	874.1659072	288.62645	2333464.153	1174876.08	36007.539
13	3840	865.0835119	109.02704	142653.3747	760822.4585	31001.239
19	3840	838.9926384	144.69048	1391684.467	878245.1763	32932.319
22	3840	864.8047521	273.47397	751864.3728	715220.1267	34005.847
23	3840	872.1697458	295.65023	172620.3171	1238841.862	35998.99
24	3840	764.6291255	267.81203	1445013.686	282790.4266	29984.251
27	3840	758.3371174	114.9272	2139068.5	507043.2137	30990.616
28	3840	881.1540899	70.0972	1899238.32	965557.1915	40971.936
32	3840	810.2982215	158.40927	1710313.384	296227.726	28994.784
33	3840	620.6597574	301.98527	331033.536	1184998.653	18000.115
34	3840	805.258346	80.76555	2688628.503	1123766.876	34978.15
35	3840	790.3322563	109.35796	2794777.464	960821.6685	35000.024
36	3840	787.6016591	352.08552	1262027.556	563094.6295	31997.862
38	3840	796.4978798	69.98723	1831241.657	947114.0418	35001.779
43	3840	721.3215126	136.5806	630916.9313	1359240.454	23451.309
44	3840	840.960355	271.53957	114958.8976	1175003.619	32002.106
45	3840	855.2818515	277.28872	1588291.401	742800.0004	32000.034
46	3840	771.1514814	203.81081	736017.9212	735463.8315	27793.787
47	3840	743.1832456	210.48369	529483.2556	768696.6154	26005.935
48	3840	862.0100145	304.70771	766688.9332	1019213.971	29999.521
50	3840	899.0113411	69.77021	1584892.384	879389.5917	34985.627
51	3840	812.2941599	87.50778	791513.5175	1164208.975	36016.726
52	3840	812.2613646	79.12999	2247183.207	1067151.93	31000.006
53	3840	843.5988131	105.57828	224600.4861	897587.3028	36997.838
54	3840	828.1796787	276.29254	464714.3164	726895.89	24000.901
55	3840	817.4104461	281.93697	2431580.07	666097.4796	31983.789
56	3840	881.5908025	88.91721	786859.9618	1094918.316	39000.059
58	3840	902.1516562	101.23739	2511043.599	854700.768	32999.998
59	3840	883.2054679	90.04686	270354.9526	929570.9292	39002.646
2	3900	862.0898832	97.83197	867804.0698	912278.853	34211.48
3	3900	898.0685327	97.34048	2004661.884	795909.2015	35332.651
6	3900	877.7211829	89.19283	554597.0204	927382.5604	34129.831
7	3900	900.1365314	266.40827	1744437.802	1396059.738	36009.865
10	3900	834.2198102	270.76025	1988858.196	285560.4992	35984.552
12	3900	873.0996146	285.13849	2274855.581	1188817.398	36056.828

13	3900	864.2243649	107.92616	142653.3747	746440.5182	30999.979
16	3900	690.7859867	270.5454	2739598.401	395390.4089	30001.77
19	3900	844.4759194	144.73464	1426145.818	841764.8501	33000.566
22	3900	865.1351589	273.34905	691717.0103	717918.281	33990.891
24	3900	764.3595126	267.04761	1391773.739	280904.487	29989.318
27	3900	758.7031083	115.72102	2187399.495	489596.7984	30983.109
28	3900	879.5607302	70.21682	1956958.146	981085.6611	41019.43
32	3900	812.9748292	134.56907	1744902.391	261920.6818	29002.108
33	3900	620.4412338	301.01522	290634.2355	1203152.689	17999.995
34	3900	804.1433066	80.86285	2744752.652	1130486.517	35015.312
35	3900	790.3176434	109.47896	2847046.084	947068.5358	35000.014
36	3900	786.7083782	352.06561	1254451.217	604339.9811	32020.155
38	3900	796.6162328	70.0711	1883587.823	961310.5273	34977.653
39	3900	687.2645102	175.48432	786405.547	903667.8635	20655.932
43	3900	700.3654424	166.04467	648442.9568	1322498.337	21492.28
45	3900	855.2724814	277.17537	1528715.203	748490.0144	32000.035
46	3900	801.8553341	203.58599	713429.0714	696643.4824	29801.525
47	3900	791.1592773	234.52032	496429.3003	735273.6673	26004.214
48	3900	863.5440303	284.84601	709282.2585	1036139.385	30001.999
50	3900	898.4841626	69.65777	1643853.198	895718.1124	35000.906
51	3900	810.6269551	88.13642	849057.2967	1165742.497	35979.851
52	3900	812.2613646	79.25517	2304508.008	1075276.584	31000.005
53	3900	829.4194294	96.49906	281446.6548	888384.7577	37000.461
54	3900	827.9579202	271.77982	404327.3939	729534.6209	24000.127
55	3900	817.4881955	281.79753	2375540.532	674985.5136	31983.113
56	3900	881.3322329	89.65449	848859.8443	1095382.904	38999.985
58	3900	902.1471942	101.32792	2573389.689	845376.2448	33000.003
59	3900	874.9664913	90.17897	332789.4973	929478.1291	38978.959
2	3960	862.07092	97.7892	928414.01	906067.8374	34298.571
3	3960	898.7975025	97.40759	2066420.345	789906.6576	35281.048
6	3960	882.6160453	89.73822	616038.943	927837.8624	34082.388
7	3960	900.0614592	266.27984	1680393.83	1393058.494	36017.855
10	3960	832.8947248	270.65738	1932325.489	286094.471	36007.845
12	3960	877.2842472	277.79902	2214196.638	1197331.318	36052.306
13	3960	864.0232429	108.50065	142653.3747	732064.8818	31000.012

16	3960	702.691676	270.4754	2688389.952	395736.8506	30005.76
19	3960	845.5318381	144.79425	1460411.473	805362.3409	33000.046
20	3960	880.609956	268.17539	3234390.575	1435622.331	35980.511
22	3960	865.0659988	273.23191	631557.5956	720521.875	33981.829
27	3960	758.9516385	116.07253	2235069.818	471949.7065	30988.867
28	3960	880.0313536	70.34452	2014848.627	996542.7355	40982.537
32	3960	811.0286414	132.00368	1788678.925	230979.5592	28999.957
33	3960	620.4053151	300.88398	250046.2181	1221097.879	18000.02
34	3960	805.3598552	80.9713	2801430.754	1137192.607	34998.54
35	3960	790.3087195	109.55482	2899276.564	933237.3039	35000.008
36	3960	786.6093231	352.05227	1246845.921	645588.3981	32006.347
38	3960	795.7043234	70.1833	1935991.455	975435.0912	34994.368
39	3960	708.8655542	173.23291	792245.1439	865354.6624	22679.586
41	3960	676.6974035	273.51379	446932.6054	1167378.349	20089.158
45	3960	855.2551914	277.05035	1468850.625	754111.9679	32000.025
46	3960	832.6709584	203.47345	690401.5779	656694.1068	31783.945
47	3960	797.232204	253.41387	443584.8489	718596.247	26001.759
48	3960	862.4189515	281.95666	648465.9142	1046415.215	30000.023
50	3960	898.2466757	69.70169	1702853.735	912062.5179	35016.329
51	3960	810.084606	88.0561	906054.2143	1167125.018	35979.639
52	3960	815.1286088	104.97356	2362175.928	1072354.46	31002.977
53	3960	825.825781	93.14767	338675.4806	885240.417	36999.822
54	3960	827.8464832	271.35399	344066.5127	730640.3654	23999.998
55	3960	817.4691206	281.68689	2319483.825	683778.5397	31982.619
56	3960	881.2597264	89.73265	910851.6081	1095617.014	39000.027
58	3960	902.1407244	101.42923	2635763.467	835961.9082	33000.009
59	3960	868.7046013	91.61885	395314.4981	929079.2232	39012.709
2	4020	862.0760512	97.81058	988713.0249	899890.2965	33992.755
3	4020	898.7562295	97.51745	2128157.762	783828.1022	35209.384
6	4020	885.9699759	90.66914	678724.1419	927656.3371	34116.996
7	4020	900.2265511	266.13001	1616483.717	1389950.532	36020.168
10	4020	833.9687144	270.55333	1875557.331	286552.133	36002.205
12	4020	877.1136895	274.96498	2152414.817	1202138.63	36030.592
13	4020	864.0046143	108.99756	142653.3747	717174.9876	31000.026
14	4020	865.3863663	279.01065	2792303.276	267738.786	36010.158

16	4020	710.803822	270.39358	2638905.553	396022.7898	30020.281
19	4020	845.7977698	144.85635	1494745.735	768747.4382	33000.006
20	4020	880.4045951	268.29805	3171159.961	1434144.255	35988.957
22	4020	864.41634	273.11737	570828.8532	723056.9253	33995.989
27	4020	758.6709823	116.16976	2282618.393	454177.6116	31005.15
28	4020	881.2936371	70.46729	2072824.663	1011907.809	40961.457
32	4020	810.5972832	132.53836	1830514.658	201748.9195	29000.002
33	4020	620.4019687	300.82722	209353.7526	1239021.974	18000.008
34	4020	804.8883394	81.07866	2857649.829	1143762.905	34986.561
35	4020	790.3252287	109.62395	2951461.595	919364.8803	35000.005
36	4020	787.1740934	352.0399	1239146.552	687209.9613	31987.824
38	4020	795.1907538	70.2964	1988517.874	989494.9569	35022.907
39	4020	744.2461918	189.08334	792554.5725	825759.9674	24097.113
41	4020	701.9552324	271.35762	395048.6212	1168686.63	22101.19
45	4020	855.307173	276.98071	1409208.906	759632.3766	32000.033
46	4020	857.6695484	203.41966	666567.7135	615122.6024	32001.478
47	4020	797.0811672	253.8568	387961.9591	706799.3667	26000.003
48	4020	862.0478294	281.95779	587692.8946	1055928.898	29999.994
50	4020	898.6425616	69.8213	1761929.029	928335.6423	35017.809
51	4020	809.3917779	87.86648	963056.9296	1168631.208	35999.269
52	4020	813.02603	109.55827	2417701.488	1058788.144	31000.054
53	4020	824.818386	93.08167	396091.1097	882962.4701	36999.977
54	4020	827.8219425	272.44107	283977.6516	732275.0153	24000.025
55	4020	817.3979527	281.58939	2263288.031	692510.5857	31982.083
56	4020	881.2423248	89.77398	972670.4172	1095814.943	39000.03
58	4020	902.1483097	101.537	2698044.97	826468.5354	33000.018
59	4020	867.4284858	94.41477	455811.7445	926511.4258	39032.116
2	4080	862.0801785	97.89283	1048987.539	893675.6738	34048.429
3	4080	897.7702518	97.64032	2189348.376	777703.0481	35199.424
6	4080	890.0387096	94.70957	740506.1337	925656.9422	34321.493
7	4080	900.6055931	267.89442	1552532.234	1387585.929	36015.537
10	4080	862.006668	270.45259	1818045.709	286936.1062	36017.501
12	4080	874.9247721	274.43002	2090617.007	1205767.189	35978.111
13	4080	863.9487284	109.26457	142653.3747	702110.764	31000.001
14	4080	867.4291551	274.22577	2733921.085	272991.9246	36053.634

16	4080	722.0532711	270.34625	2587732.573	396272.4871	29996.594
19	4080	845.8657029	144.91634	1528834.717	732255.2999	32999.999
20	4080	879.1233483	268.78933	3108537.346	1432995.758	36022.412
22	4080	864.074109	272.99463	510641.1646	725474.1476	34011.984
27	4080	758.0658313	116.18579	2330128.824	436372.7577	31018.189
28	4080	880.4658353	70.57974	2131280.802	1027289.341	41002.366
32	4080	810.4493698	133.0566	1872022.142	172109.3337	29000.013
33	4080	620.3992915	300.76096	168503.2887	1256958.173	18000.004
34	4080	804.2627751	81.18297	2913880.372	1150252.828	35024.412
35	4080	790.3135161	109.71845	3003488.636	905460.6663	34999.999
36	4080	774.7499264	352.02546	1231260.126	729697.5753	30420.153
38	4080	796.2047302	70.40397	2041077.427	1003469.871	35011.46
39	4080	742.4555028	204.17522	775236.0982	787248.571	24146.814
41	4080	729.2216047	271.91289	341944.9744	1169851.434	24100.342
45	4080	855.253072	276.85918	1349252.775	765106.5301	32000.015
46	4080	859.745021	203.38485	642686.5441	573315.2314	32000.099
47	4080	797.008326	251.75751	333117.9468	693740.515	26004.361
48	4080	862.0052179	282.16856	526912.8499	1065589.546	30000.019
50	4080	899.2931128	69.9644	1821138.027	944516.4728	35001.471
51	4080	809.0053737	87.76455	1020030.654	1170247.909	36020.508
52	4080	812.4468698	109.50548	2472600.485	1044242.147	30999.991
53	4080	824.5405185	93.35542	453300.6693	880550.5505	37000.021
55	4080	817.2925393	281.49216	2207128.223	701159.3343	31982.497
56	4080	881.2330663	89.84592	1034749.062	1095968.005	39000.022
58	4080	902.166269	101.64782	2760343.828	816875.5271	33000.03
59	4080	864.7120552	95.60394	515981.5319	922461.7445	38983.597
2	4140	862.0927835	98.01127	1109485.2	887350.1258	34194.322
3	4140	897.7256324	97.76863	2251019.993	771423.2241	35224.59
6	4140	892.1978435	97.73403	802069.9658	920419.7891	34199.999
7	4140	900.9800616	268.84992	1488591.537	1386361.205	36006.568
10	4140	873.5493783	270.33617	1759057.744	287246.6258	35981.766
12	4140	874.5919112	274.78549	2029087.92	1209412.532	36001.373
13	4140	863.9689187	111.88897	142653.3747	686551.1972	30999.966
14	4140	868.6595357	271.46601	2675194.417	275000.7059	36012.798
16	4140	734.2328122	270.26419	2536516.639	396481.0223	30012.214

19	4140	845.8741806	146.31218	1562757.703	695718.1877	32998.701
20	4140	879.1738798	269.17214	3045872.209	1432211.744	36000.319
22	4140	864.2651917	272.55188	450416.9246	727685.0069	34018.589
27	4140	757.7720124	116.21158	2377592.965	418559.1557	31015.708
28	4140	879.4679218	70.68938	2189315.221	1042454.499	41008.463
32	4140	810.4581821	133.31285	1913523.709	142038.821	29000.035
34	4140	805.5690087	81.29533	2970142.535	1156664.615	34987.197
36	4140	750.8384886	346.72778	1222713.998	771769.0992	28513.83
38	4140	796.7068103	70.50582	2093760.638	1017390.103	34980.811
39	4140	740.720588	208.17159	750546.5293	750940.2402	24052.21
41	4140	758.0591384	271.88817	286880.0312	1171215.111	26111.5
45	4140	855.2710313	276.72879	1289562.82	770452.9712	32000.019
47	4140	791.0881093	250.88195	278950.0375	679825.3355	26013.534
48	4140	862.0172651	282.24636	466075.2035	1075373.366	30000.02
50	4140	899.4793989	70.1007	1880397.073	960578.5334	34984.281
51	4140	809.722854	87.77127	1077537.56	1171910.627	36017.497
52	4140	812.3132347	109.16653	2527723.477	1029878.817	31000.017
53	4140	824.4528413	93.56089	510569.0828	877952.627	37000.021
55	4140	817.0556101	281.3933	2150418.254	709813.1847	31987.735
56	4140	881.222246	89.93935	1096707.977	1096053.271	39000.012
58	4140	902.1986181	101.76029	2822507.766	807204.5029	33000.037
59	4140	864.2400933	95.88428	576061.7867	917902.5471	38976.266
60	4140	868.0242666	70.60213	2143318.534	1030443.372	34984.426
61	4140	866.8866944	295.60385	1682955.977	1606961.552	34007.272
2	4200	862.0769436	98.12897	1169683.766	880958.8807	34138.129
3	4200	898.348408	97.89585	2312714.766	765035.2871	35179.493
6	4200	888.8663342	98.72337	863646.0697	913631.3216	35996.209
7	4200	901.2894973	268.98332	1424601.407	1385523.639	35995.719
10	4200	876.5319637	269.7269	1699697.216	287334.395	35996.975
12	4200	873.4727445	275.22449	1967661.727	1213406.711	36022.66
13	4200	867.0854739	118.99452	142653.3747	666089.0461	30884.019
14	4200	865.7732167	270.75992	2615965.563	275774.471	36006.202
16	4200	735.9166377	270.15022	2484950.876	396621.478	30003.329
19	4200	847.0124221	163.49236	1585077.995	654486.4643	33001.692
20	4200	880.1848444	269.30982	2983227.96	1431625.178	35980.224

22	4200	864.9440762	272.06857	390185.749	729484.1438	34006.009
27	4200	757.300162	114.0195	2425094.039	400890.9733	31016.8
28	4200	880.8276988	70.80865	2247417.753	1057532.142	40961.038
32	4200	807.1453014	133.43757	1954540.517	112112.153	29007.375
34	4200	804.5221255	81.40756	3026436.336	1162995.352	35000.056
36	4200	730.2163948	313.53575	1194073.125	805984.5516	26908.483
38	4200	795.6560228	70.60438	2146916.879	1031349.608	34997.571
39	4200	736.2517296	206.8191	725516.3065	714979.5896	23984.437
41	4200	795.4265674	271.77198	230454.777	1172545.74	27883.08
45	4200	855.5884985	285.49125	1229798.829	776618.0391	31997.558
47	4200	789.4108652	250.70022	224688.8913	665494.6931	26012.146
48	4200	862.0549685	282.22121	405294.0559	1085159.184	30000.014
50	4200	899.1533424	70.22247	1939708.296	976531.8972	34984.733
51	4200	810.5286808	87.85029	1134546.763	1173522.937	35994.03
52	4200	812.28769	109.04615	2582676.579	1015731.157	31000.023
53	4200	824.4672311	93.70415	567938.1583	875221.8277	37000.034
55	4200	816.900223	281.2929	2094088.081	718328.6646	31991.987
56	4200	881.2257041	90.04423	1158466.902	1096058.347	39000.006
58	4200	902.1597992	101.87257	2884626.813	797441.0536	32999.998
59	4200	864.3970421	95.82958	636006.6153	913297.9712	38972.317
60	4200	868.2103296	70.71394	2201026.373	1045501.555	34981.328
61	4200	866.9038729	295.33322	1626247.517	1626522.867	34019.101
63	4200	854.5731835	273.07166	2511638.757	615901.1837	35978.012
64	4200	830.2191211	80.28358	2639703.087	1117936.068	30983.22
2	4260	862.0777244	98.2424	1229890.543	874472.4042	33721.308
3	4260	898.9372729	98.02535	2374342.97	758549.2209	35482.348
6	4260	889.0880928	98.56526	924815.3644	906630.5105	35400.954
7	4260	901.3307703	268.64596	1360070.858	1384558.84	35981.807
10	4260	876.5389913	268.94958	1640219.678	286760.2131	36018.851
11	4260	835.3178942	44.33983	954936.5452	512011.8246	27667.036
12	4260	873.7213862	275.48742	1906176.341	1217685.688	36000.713
13	4260	863.3163596	119.29274	142653.3747	643316.3106	29820.643
14	4260	864.7417271	270.94267	2557299.143	276422.3563	36010.938
16	4260	737.5878582	270.54328	2433274.725	396772.7679	29988.699
19	4260	846.1789313	165.63875	1600364.937	611201.6212	32999.985

20	4260	879.5895098	269.26512	2920632.785	1431063.459	36012.785
22	4260	864.9876917	271.92034	328334.8704	731031.9524	33983.461
27	4260	763.7221242	94.15417	2478067.701	392109.8466	31091.062
28	4260	881.1306647	70.94943	2305601.413	1072515.333	40981.364
32	4260	803.8478144	133.55807	1995122.082	82338.65209	28985.062
34	4260	805.1766924	81.52635	3083245.253	1169290.377	35010.664
36	4260	697.7129292	300.60104	1151833.845	828071.5592	25371.051
38	4260	795.3937722	70.7036	2199839.8	1045162.211	35024.677
39	4260	750.9037445	204.49814	701848.1938	677585.0237	24005.914
41	4260	805.2081491	271.64928	171655.8821	1173841.04	28001.01
45	4260	857.6030655	305.87686	1177124.595	798352.6594	32002.016
47	4260	789.2543625	251.01404	170959.4757	651428.0972	25999.655
48	4260	862.0094567	282.14492	344381.3288	1094916.345	30000.003
50	4260	898.5599041	70.33498	1999202.129	992420.6762	35003.657
51	4260	810.4875194	87.95895	1191558.352	1175064.336	35976.779
52	4260	811.4160496	109.05751	2637834.697	1001555.403	30989.138
53	4260	824.4404595	93.82175	625061.5684	872406.8879	37000.018
55	4260	815.75395	281.18574	2036538.891	726945.0755	31507.535
56	4260	881.226708	90.15461	1220602.349	1095976.539	39000
59	4260	864.5617993	95.74232	695940.9774	908761.0777	38976.389
60	4260	868.3697325	70.83077	2258817.146	1060476.404	34980.831
61	4260	867.7721669	295.06942	1568795.112	1646080.907	34000.724
63	4260	853.3917727	271.1398	2452938.06	617441.6313	36023.62
64	4260	830.4425528	80.81816	2698742.091	1125198.483	30983.107
2	4320	862.0886562	98.35411	1290090.931	867894.4375	33689.385
3	4320	898.9210983	98.11744	2436144.841	751939.815	35508.498
6	4320	889.3957437	97.98221	986146.3099	899979.5438	35411.554
7	4320	901.0833556	268.2577	1296158.137	1383255.735	35982.886
10	4320	876.3512551	268.48526	1580788.053	285701.7938	36016.28
11	4320	807.2739169	44.44632	997022.4728	544672.2415	25614.173
12	4320	874.5901264	275.54056	1844723.589	1222075.212	35979.419
13	4320	785.6176564	118.95403	142653.3747	621745.8624	27639.44
14	4320	865.9138794	271.30022	2498639.839	277317.3079	35979.408
16	4320	736.4772808	271.10044	2381615.447	397383.2701	30020.701
19	4320	845.9643118	165.46189	1615012.528	568007.6189	33000.001

20	4320	878.9169835	269.13213	2857995.269	1430421.194	36015.175
22	4320	864.4096471	272.35566	268027.3551	732766.7259	33999.793
27	4320	762.695989	86.06187	2532479.044	392937.1681	31115.133
28	4320	881.7425085	95.78386	2366515.921	1078944.797	41063.172
29	4320	897.7264132	90.79208	221521.1649	18798329.71	40955.657
32	4320	802.385859	133.64958	2035526.301	52550.95255	29016.271
34	4320	805.2513184	81.59206	3139610.491	1175476.534	34980.89
36	4320	669.0683744	301.43317	1108840.088	846953.7585	23559.473
38	4320	796.3859966	70.80825	2252311.262	1058770.935	35007.72
39	4320	756.4368877	203.03275	679956.0601	639713.0031	24015.798
45	4320	855.9068581	308.17365	1129283.58	826243.1185	32000.001
48	4320	862.0100145	282.04594	283436.179	1104600.4	30000.018
50	4320	898.4694382	70.4435	2058707.935	1008204.7	35018.918
51	4320	809.7399209	88.07195	1248567.684	1176523.313	35989.187
52	4320	805.1571714	109.12761	2692446.365	987475.9293	30989.893
53	4320	824.4419096	94.28972	682282.5956	869477.02	36999.991
55	4320	803.6867383	281.08418	1980382.083	735269.5102	30426.471
56	4320	881.2319508	90.26623	1282398.353	1095806.075	38999.994
59	4320	864.4647521	95.72106	755653.1218	904284.6841	38988.626
60	4320	867.56926	71.79114	2316741.96	1075327.895	34993.216
61	4320	867.9889057	294.8732	1511857.47	1665250.06	33984.851
63	4320	854.0949748	269.93593	2394205.906	617762.0797	35980.648
64	4320	836.4363916	81.04081	2757880.703	1132155.159	31000.151
65	4320	804.6355704	290.41172	2373569.971	235171.2235	26014.872
2	4380	862.0753819	98.46503	1350477.187	861204.7743	33650.851
3	4380	898.3284408	98.19407	2497669.718	745304.0038	35574.118
6	4380	888.2115442	97.80969	1047495.132	893641.6759	35328.849
7	4380	900.7424632	268.05636	1232249.447	1381738.035	35992.127
10	4380	876.8959467	268.48368	1521356.703	284497.4669	35993.982
11	4380	776.6746968	44.62488	1037031.443	575517.1213	23607.8
12	4380	874.5836566	275.46397	1783272.872	1226444.628	35998.277
13	4380	736.444374	128.95525	142653.3747	600728.8546	25434.732
14	4380	865.0955592	271.50007	2439962.292	278435.6385	36018.13
16	4380	737.3192493	271.21755	2329962.822	398205.2406	29984.168
19	4380	845.9048565	165.1951	1629969.936	524694.5436	33000.032

20	4380	879.6200741	268.96856	2794799.416	1429650.348	35988.612
26	4380	676.8116293	335.07631	2836927.475	821722.0223	24006.416
27	4380	758.8729967	86.32288	2585426.521	395988.885	31011.652
28	4380	884.2581517	111.06262	2426096.929	1066947.596	41069.209
29	4380	896.8887951	89.20414	285750.5848	18219418.87	40894.33
32	4380	802.3050979	124.87648	2076849.192	23688.72723	29023.466
34	4380	804.2561937	81.70344	3195983.509	1181590.883	35023.231
36	4380	643.291287	306.53974	1068768.204	867369.6774	21939.698
38	4380	796.545288	70.93573	2305702.561	1072523.32	34977.788
39	4380	757.5380951	202.9244	658617.1791	601306.6155	24013.8
45	4380	855.4756114	305.6765	1080864.48	853211.0209	32000.029
48	4380	862.0390171	281.93832	222542.3626	1114186.294	30000.024
50	4380	899.0970104	70.5549	2118294.854	1023903.904	35009.937
51	4380	809.0788842	88.18532	1306097.932	1177908.951	36020.714
52	4380	803.5634772	109.23748	2746681.085	973411.2268	30997.299
53	4380	824.4612075	95.50442	739386.3597	865677.8107	37000.035
55	4380	787.9400974	280.97777	1923911.895	743555.6134	28720.43
56	4380	881.2204613	90.37936	1344256.307	1095545.499	39000.001
59	4380	864.2892862	95.76866	815568.9908	899780.3424	38999.107
60	4380	877.2293653	98.91251	2377224.738	1078062.347	35112.717
61	4380	867.4872719	294.7316	1454515.235	1684393.567	33988.737
63	4380	853.639299	269.54763	2335290.608	617511.6883	36016.812
64	4380	837.8509389	81.07871	2817561.206	1139105.157	31000.07
65	4380	827.5214307	290.35294	2319830.002	250514.3563	26018.346
66	4380	834.1798758	81.22762	2936424.469	1152806.488	27000.019
2	4440	862.0776129	98.57552	1410614.521	854451.8102	33601.338
3	4440	897.7435917	98.33585	2559153.03	738576.0222	35548.539
6	4440	889.5136505	97.87653	1108626.972	887350.2516	35285.309
7	4440	900.4131719	267.90956	1168362.511	1380081.146	36004.821
10	4440	877.5804087	268.19374	1461874.343	283244.3501	35979.842
11	4440	746.4615462	44.85358	1076322.389	605553.7675	21610.311
12	4440	873.8986369	275.33332	1721263.461	1230762.946	36017.955
13	4440	701.9544516	140.44139	142653.3747	572099.3627	23240.261
14	4440	864.9521077	271.52245	2381298.95	279634.9853	36001.008
16	4440	737.4294593	271.10929	2278238.733	399011.3753	30006.817

19	4440	845.8971596	165.07549	1645021.171	481610.6568	33000.03
20	4440	880.2922657	268.81512	2732218.934	1428761.25	35987.073
26	4440	685.9928566	335.1101	2815269.659	856695.9871	23992.951
27	4440	760.5983183	89.98959	2638327.744	397069.3006	31088.286
28	4440	883.7102251	114.8401	2482704.701	1048425.274	41011.287
29	4440	896.4148253	88.81174	347665.23	18076362.7	40895.125
32	4440	811.5822569	104.21753	2128613.806	7311.714168	29125.297
34	4440	805.6860232	81.83763	3252403.261	1187616.159	34988.044
36	4440	627.8353416	309.4927	1032114.724	889310.4574	20172.068
38	4440	798.2905767	77.1802	2359320.652	1083784.465	35071.528
39	4440	758.015746	203.31093	637053.5907	563107.682	24001.94
45	4440	855.3298174	305.24712	1031426.57	879494.1145	32000.017
48	4440	862.0119108	281.82691	161465.9263	1123706.282	30000.004
50	4440	899.6149304	70.67008	2177998.336	1039525.814	34988.597
51	4440	809.6263645	88.29662	1363132.086	1179199.479	36020.63
52	4440	803.0474535	109.36192	2800804.98	959269.0295	31003.826
53	4440	824.4594227	95.74989	796441.5525	861443.3763	37000.033
55	4440	756.8926751	280.87006	1869527.754	751453.0376	26733.702
56	4440	881.2176726	90.49364	1406317.633	1095192.668	39000.012
59	4440	863.9931248	95.86253	875459.7541	895218.1208	39009.233
60	4440	878.3294572	114.45032	2434981.203	1061985.507	35021.186
61	4440	866.9559661	294.6196	1397216.14	1703396.27	34008.708
63	4440	853.6465496	269.59195	2276514.223	617163.4684	35990.854
64	4440	838.1880386	81.14108	2877112.395	1146000.77	31000.019
65	4440	829.5219426	290.23412	2263448.744	266530.4155	26000.046
2	4500	862.0814055	98.687	1470744.986	847608.345	33458.499
3	4500	897.9304356	98.46588	2620640.164	731733.8276	35428.759
6	4500	888.6778172	98.02981	1169921.422	880939.1754	35221.83
7	4500	900.3141167	267.79001	1103892.764	1378301.071	36019.524
10	4500	877.7724953	267.2651	1402282.075	281374.486	35989.521
11	4500	722.4278512	45.01141	1114405.461	634398.4552	19608.379
12	4500	873.498066	275.19198	1659679.572	1234938.737	36015.621
13	4500	670.1932301	141.58267	142653.3747	542420.7119	21033.095
14	4500	865.9873899	271.41509	2322317.404	280799.1601	35981.45
16	4500	737.8845774	270.94955	2226350.196	399718.5224	30012.133

19	4500	845.8887935	165.04688	1660175.315	438358.4175	33000.017
20	4500	879.3851528	268.67446	2669655.715	1427754.799	36018.893
26	4500	687.0739852	335.13474	2793777.419	891406.3148	24018.056
27	4500	758.4892697	91.53209	2691388.288	396365.5387	30990.254
28	4500	882.4769442	113.33853	2538900.037	1029560.582	40986.482
29	4500	902.5718596	89.02902	410265.119	18155575.87	41010.124
34	4500	804.3429785	81.96943	3309359.008	1193597.627	35010.372
36	4500	606.3238711	312.5698	997095.2919	911579.2775	18186.098
38	4500	798.3973287	80.47593	2414723.832	1091603.067	35067.673
39	4500	758.4198865	203.43418	615243.0222	524839.5691	23991.281
45	4500	855.3133082	305.43678	981909.2377	905750.0589	32000.031
50	4500	899.289097	70.78986	2237781.909	1055056.642	34983.427
51	4500	810.5363776	88.4052	1420185.967	1180410.692	35995.643
52	4500	802.8198945	109.49015	2855310.903	944919.8502	31015.332
53	4500	824.4227232	95.84722	853574.8539	857093.3441	37000.017
56	4500	881.2192342	90.60755	1468121.532	1094750.028	39000.025
59	4500	863.6704148	95.97536	935308.4364	890574.2876	39019.003
60	4500	871.1732825	113.99987	2491018.66	1042992.209	34994.825
61	4500	867.260159	294.51485	1339457.795	1722440.086	34015.712
63	4500	859.7771469	248.17863	2219306.292	608282.6581	36074.483
64	4500	838.265788	81.23413	2936951.955	1152864.668	31000.006
65	4500	836.7623365	299.50432	2208760.234	286195.9731	26154.862
66	4500	834.1915884	81.47226	3057311.823	1166410.101	27000.016
69	4500	839.7191542	272.74055	211881.2947	824819.8186	31999.901
70	4500	873.2071474	87.54448	1563897.869	1061730.251	35018.329
71	4500	874.2979807	141.86145	1389110.483	612748.7358	37010.556
2	4560	862.0891024	98.80153	1530788.873	840682.1189	33388.553
3	4560	898.4855012	98.57087	2682069.815	724775.9868	35403.84
6	4560	888.7730796	98.2013	1230956.37	874416.2988	35117.468
7	4560	900.7459212	267.67815	1039981.466	1376443.018	36014.956
11	4560	696.3679882	45.05554	1151574.065	662462.0148	17610.965
12	4560	874.0990897	275.05393	1598055.627	1239005.085	35991.04
13	4560	640.7556767	141.27506	142653.3747	513838.2587	18832.182
14	4560	865.0619831	271.25172	2263674.803	281845.2338	36019.746
16	4560	746.2704635	270.80658	2174269.059	400322.745	29984.236

19	4560	845.9070874	165.05622	1675243.279	395293.1397	33000.011
20	4560	879.0583155	268.39444	2606978.977	1426600.57	36011.021
26	4560	688.3823383	335.12536	2772587.599	925587.3766	23995.756
27	4560	758.8183379	91.30106	2744218.947	395269.5675	30984.602
28	4560	882.9493524	110.93072	2595928.726	1012345.697	41038.717
29	4560	913.1059479	89.34686	474164.1768	18271449.9	41000.026
38	4560	796.7387132	81.37903	2470453.427	1098071.753	34997.447
39	4560	758.7635676	203.39757	593414.9606	486525.8906	23985.304
45	4560	855.2826324	305.40402	932630.0048	931958.3059	32000.033
50	4560	903.3701011	70.97273	2297232.797	1070368.08	35007.755
51	4560	810.5310233	88.51118	1477229.427	1181543.794	35976.834
52	4560	802.8965283	109.57994	2909246.669	930614.5217	31018.445
53	4560	824.4589765	95.92752	910454.5745	852694.8602	37000.1
56	4560	881.2185649	90.7219	1530185.791	1094213.873	39000.033
59	4560	863.346924	96.09229	995132.1436	885839.3945	39026.036
60	4560	869.8325803	111.65016	2547984.306	1025230.79	35076.273
61	4560	867.9330199	294.41159	1282152.541	1741228.906	33999.188
63	4560	858.1543385	237.17759	2167082.383	586588.8464	36088.668
64	4560	835.8651514	81.34302	2996497.513	1159612.51	30999.711
65	4560	838.4550859	305.1961	2159122.094	311108.1397	26187.763
66	4560	834.1756369	81.55445	3117743.601	1173071.262	27000.006
69	4560	841.5033734	272.62892	152289.9261	826914.3999	32000.087
70	4560	873.1889649	87.66299	1625333.878	1063634.43	35018.458
71	4560	873.932213	142.42767	1425955.159	576786.0222	36994.601
2	4620	862.0982494	97.6281	1590798.748	833923.0792	33328.844
3	4620	899.0720235	98.48966	2742976.966	717903.0369	35389.592
6	4620	889.6451663	98.35373	1292200.712	867738.1391	35153.999
7	4620	901.2639527	267.56518	976115.2663	1374495.467	36001.625
12	4620	874.7565569	274.9273	1536503.561	1242962.528	35980.755
14	4620	865.0830657	271.15241	2205204.695	282769.017	35997.261
16	4620	748.5374649	270.69292	2120939.987	400852.0496	29991.646
19	4620	845.8371465	165.07795	1690332.825	352037.9597	32999.993
20	4620	879.9834993	268.01673	2544418.538	1425145.339	35981.379
26	4620	688.0005076	335.09308	2751330.736	959790.4916	23986.556
27	4620	759.0522553		2797142.101	394681.3792	30983.735

28	4620	880.4869179	109.24869	2654280.618	996576.9736	41044.775
29	4620	912.4818337	89.56724	538001.214	18351793.22	41000.017
38	4620	796.5593431	81.23445	2526056.12	1104348.169	34979.351
45	4620	855.3013725	305.28276	883009.5298	958225.6335	32000.024
50	4620	905.654504	101.68813	2359678.112	1074491.879	35006.088
51	4620	809.4600456	88.61352	1534806.207	1182610.267	36001.083
52	4620	803.0580506	109.63714	2963151.949	916265.9552	31018.167
53	4620	817.103576	96.01479	968679.0181	848132.371	36968.573
56	4620	881.2095295	90.83511	1591981.24	1093588.942	39000.024
59	4620	863.1319699	96.20738	1055013.19	881006.6371	39029.349
60	4620	868.1138401	109.68703	2604931.659	1009389.549	35002.418
61	4620	867.8354149	294.30328	1223972.562	1760194.897	33983.302
63	4620	856.477429	234.72516	2117678.243	560666.2239	36035.035
64	4620	833.7564374	81.46749	3056155.884	1166279.357	30999.928
65	4620	836.0591344	306.38671	2111123.874	337964.9202	25985.317
70	4620	873.5028626	87.78911	1687310.431	1065457.413	35013.396
71	4620	874.4922983	142.76341	1462367.05	540615.356	37004.417
72	4620	877.4368457	89.46727	1994032.278	1188243.597	37000.022
73	4620	877.4298181	97.9196	2021208.072	915340.5012	37000.023
2	4680	862.1032691	96.67801	1651094.027	828394.6198	33401.385
3	4680	899.03287	98.5315	2804415.702	710978.4894	35354.382
6	4680	888.312161	98.47758	1353271.079	860964.3757	35208.599
7	4680	901.5231916	267.44795	912255.2845	1372454.667	35987.333
8	4680	587.2410359	271.32455	2250955.885	1364545.248	17768.785
12	4680	874.5711632	274.81097	1474937.763	1246823.807	36002.714
14	4680	866.0585579	271.06734	2146321.511	283645.3349	35983.571
16	4680	753.9274913	270.59676	2068218.682	401302.0477	30017.08
19	4680	845.8458473	165.10089	1705307.328	308967.6607	33000.025
20	4680	880.3530597	267.78262	2481297.265	1423440.276	35986.994
26	4680	687.2764459	335.05231	2729831.696	994271.9382	24016.461
28	4680	880.7197198	108.62195	2712438.569	981800.243	41014.733
29	4680	905.4866235	89.72533	601663.4897	18409427.65	40999.465
38	4680	795.3961147	80.93132	2581641.246	1110823.998	35014.208
45	4680	855.2902177	305.16471	833494.1172	984290.4981	32000.015
50	4680	900.5624238	110.03346	2420182.014	1060159.229	35001.302

51	4680	809.1433592	88.71827	1591879.451	1183589.395	36024.558
52	4680	803.4350848	109.73866	3017108.655	901830.1803	31012.317
53	4680	817.1323555	96.13118	1024834.867	843653.5546	36976.476
56	4680	881.2258156	90.94916	1653767.577	1092873.143	39000.023
59	4680	862.9753557	96.31981	1114832.698	876087.0288	39030.504
60	4680	867.6403165	108.74688	2663118.56	994399.9556	35009.896
61	4680	867.3002049	294.19642	1166583.593	1778792.932	33998.08
63	4680	854.4047452	236.12856	2069215.356	535222.9219	35985.173
64	4680	833.2704204	81.55215	3115392.932	1172811.372	31000.001
65	4680	834.38836	305.33672	2062672.531	364798.9441	26006.266
70	4680	873.5715765	87.91325	1748826.783	1067159.539	35011.803
71	4680	873.7236172	142.89924	1498563.144	504315.1842	37002.446
72	4680	877.43428	89.58252	2055750.53	1188619.919	37000.033
73	4680	877.4379611	98.03205	2081705.7	909002.3737	37000.033
2	4740	862.0984725	96.69851	1711543.772	823098.0631	33478.321
3	4740	898.6405537	98.65136	2865972.72	703965.1655	35351.298
6	4740	889.0671216	98.59752	1414702.071	854049.1063	35198.439
7	4740	901.3584344	267.32833	848404.7195	1370317.177	35981.391
8	4740	609.8365353	272.91658	2205422.101	1365907.061	19766.528
12	4740	873.7573049	274.69483	1413327.641	1250593.678	36021.724
14	4740	865.0149096	270.95993	2087695.061	284439.0473	36021.269
16	4740	754.7448076	270.49122	2015271.907	401683.6826	30016.161
19	4740	849.3580652	137.56626	1733657.952	270453.0723	33004.241
20	4740	879.5803628	267.6384	2418761.016	1421604.381	36016.683
26	4740	688.2839525	335.00873	2708454.387	1028440.797	24002.918
28	4740	881.9276791	108.83211	2770607.922	967147.048	40983.223
29	4740	901.3129225	89.85957	664908.6646	18458367.15	40999.842
38	4740	796.1259769	80.75446	2636980.086	1117451.223	35016.984
45	4740	855.2875405	305.04507	783619.6224	1010401.932	32000.017
50	4740	900.0576666	110.51461	2479654.263	1043691.747	34981.166
51	4740	810.1165089	88.82685	1648952.974	1184489.501	36012.505
53	4740	817.6381167	96.26584	1081313.448	839054.3932	36978.736
56	4740	881.2278235	91.06377	1715829.994	1092062.276	39000.016
57	4740	836.1494887	348.61685	470123.3638	639783.6069	32024.743
59	4740	862.873735	96.42917	1174571.65	871085.4128	39028.518

60	4740	867.5109201	108.66996	2720928.719	979860.7749	35009.129
61	4740	867.0929477	294.08648	1108343.271	1797554.006	34017.864
63	4740	854.2000536	238.03679	2020135.282	511171.9541	36010.13
65	4740	834.2923167	303.63457	2013707.358	390410.585	26013.588
70	4740	873.6971802	87.93686	1810360.629	1068819.48	35009.395
71	4740	874.7422786	142.92488	1534620.531	468008.428	36995.362
72	4740	877.4400806	89.69901	2117573.728	1188904.36	37000.028
73	4740	877.433053	98.14463	2142370.109	902554.3822	37000.022
2	4800	862.0879869	96.85956	1771864.909	817714.0751	33502.381
6	4800	889.5490114	98.70928	1475587.387	847100.8127	35156.493
7	4800	900.6793267	267.20534	783978.0258	1368059.067	35999.005
8	4800	633.534246	273.27698	2158335.563	1367809.298	21771.86
12	4800	873.670297	274.5705	1351683.812	1254269.668	36010.491
14	4800	864.9623702	270.84208	2028738.29	285146.1994	36002.82
16	4800	762.0850375	293.57383	1963668.016	409318.4025	30077.902
19	4800	846.8343906	132.01269	1775740.919	239631.3223	33000.212
20	4800	879.1071738	267.52774	2356230.458	1419668.957	36014.413
26	4800	688.303585	334.96664	2687053.516	1062531.283	23983.946
28	4800	881.6156778	108.59464	2828709.453	952465.6412	41017.105
29	4800	900.0397073	89.93575	727900.7564	18486139.88	40999.965
38	4800	796.9109441	80.74158	2692325.543	1124139.289	34982.467
45	4800	855.6279867	298.81284	732375.6222	1034605.223	32000.547
50	4800	899.0652191	110.00339	2539018.37	1027388.101	34997.261
51	4800	810.8035364	88.93448	1706019.929	1185311.339	35984.501
53	4800	819.77271	115.18833	1135593.952	828460.9836	37081.18
56	4800	881.2183418	91.17722	1777588.386	1091164.018	39000.007
57	4800	837.233183	348.72339	458518.9862	683619.5496	32018.786
59	4800	862.8896864	96.53784	1234317.398	865996.039	39025.455
60	4800	867.4997653	109.09124	2778680.713	965139.6217	35009.647
61	4800	867.9457364	293.97162	1050363.243	1816117.072	34000.26
63	4800	853.5124683	239.24237	1970101.848	488095.292	36002.274
65	4800	834.8196068	303.07699	1963977.325	415240.7938	26000.524
70	4800	873.5587484	88.04406	1871405.845	1070408.487	35012.711
71	4800	873.5684532	142.90813	1570633.399	431696.6207	37012.202
72	4800	877.4377381	89.81776	2179457.882	1189095.412	37000.017

73	4800	877.4282564	98.25788	2202800.642	896038.6501	37000.012
2	4860	862.0918911	97.00743	1832089.762	812211.4885	35228.405
6	4860	888.3575612	98.82456	1536673.776	840034.0265	35185.382
7	4860	900.4208687	267.07571	720138.9194	1365716.558	36014.674
8	4860	658.2967993	273.29958	2109942.439	1369855.104	23771.609
12	4860	873.1833875	275.8123	1290007.65	1257991.885	36015.245
14	4860	866.0665894	270.72514	1969795.331	285761.522	35979.78
16	4860	762.2626228	309.49118	1919010.91	431658.3604	30113.757
19	4860	846.1136754	132.23799	1819023.865	209652.7105	32999.973
20	4860	879.861019	267.42492	2293718.395	1417651.065	35985.877
26	4860	695.2842939	334.92761	2665381.615	1096938.556	23514.495
28	4860	880.4243392	108.51305	2887375.078	937780.4859	41044.445
29	4860	899.6915642	86.46849	790827.1111	17222090.61	41000.024
38	4860	795.8503404	80.82665	2747874.876	1130816.618	34996.154
45	4860	855.3878226	296.499	678061.9042	1055389.467	32000.023
50	4860	898.6851731	109.40518	2598565.757	1011560.783	35018.317
51	4860	809.9157215	89.03937	1763620.96	1186062.138	35988.974
53	4860	823.3905644	130.36994	1182693.364	804408.5849	37041.21
56	4860	881.2176726	91.29164	1839638.38	1090170.021	38999.999
57	4860	838.0220544	348.71107	447000.6787	727177.7606	32011.11
59	4860	862.9723439	96.64681	1294064.36	860819.4745	39022.339
60	4860	867.5997128	109.4837	2835752.849	950211.3241	35004.149
61	4860	868.0811564	293.85709	992561.7863	1834508.692	33982.659
63	4860	854.5404998	239.56463	1919729.831	465492.9904	35989.598
65	4860	834.9230123	303.08149	1914190.442	439963.9963	25987.173
70	4860	873.9575345	88.19006	1933492.179	1071919.326	35002.613
71	4860	874.8972196	142.9289	1606629.164	395349.5594	36984.42
72	4860	877.4324953	89.94613	2241314.317	1189188.817	37000.005
73	4860	877.4469966	98.3774	2263402.723	889409.1121	37000.009
2	4920	862.095126	97.13528	1892215.962	806607.654	35212.384
6	4920	888.6893067	111.29103	1596941.709	830469.0523	35211.603
7	4920	900.3462427	266.42492	656335.3978	1363209.985	36027.739
8	4920	684.3737292	273.23376	2059777.123	1371954.321	25782.653
12	4920	876.9780464	281.46047	1228730.104	1265286.83	36072.982
14	4920	865.4818518	270.61841	1911072.65	286286.9179	36013.691

16	4920	758.7773996	308.1944	1877998.238	458326.643	30088.556
19	4920	845.9129995	132.87557	1861647.885	179484.0973	33000.023
20	4920	880.4306975	267.31982	2231210.806	1415551.414	35985.836
26	4920	676.876439	334.8857	2643647.995	1131329.94	21569.513
28	4920	880.4458681	108.56093	2945502.91	923226.5394	41023.096
29	4920	899.5388542	86.10773	853860.8559	17090569.35	40999.988
38	4920	795.7100123	80.94633	2803517.521	1137423.196	35024.227
45	4920	855.3265825	296.28727	623519.5444	1075437.067	32000.013
50	4920	899.4783949	109.05886	2658240.151	996099.7439	35005.037
51	4920	809.2320403	89.14238	1820700.481	1186729.038	36018.268
53	4920	820.251811	136.62344	1223914.157	774823.3228	37073.62
56	4920	881.2139915	91.40636	1901579.476	1089085.856	38999.994
57	4920	836.55441	348.65946	435374.3485	770911.6131	31994.676
59	4920	863.0070355	96.75629	1353704.172	855565.131	39018.134
60	4920	867.5024425	109.70126	2893598.148	934806.4419	35011.454
61	4920	867.3322194	293.7421	934240.3584	1852950.365	33999.266
63	4920	856.9097912	248.7987	1866148.02	445088.164	36053.06
65	4920	834.3832288	303.26558	1864273.986	464840.6176	25995.625
70	4920	874.0390765	88.33496	1994935.161	1073297.39	34999.756
71	4920	873.6032563	142.98445	1642835.14	358680.4871	37024.487
72	4920	877.5606646	85.45166	2303133.849	1191055.473	37000.149
73	4920	877.4661829	98.48428	2323719.825	882716.1435	37000.007
2	4980	862.0856444	97.2559	1952652.465	800872.7004	35225.52
6	4980	896.664694	131.60019	1648135.054	804714.0954	35218.994
7	4980	903.1273714	263.48573	592654.9699	1358872.522	36095.359
8	4980	711.7523194	273.14433	2008261.043	1374056.652	27786.046
12	4980	877.1934467	283.79291	1168191.836	1275517.44	35992.618
14	4980	864.8928754	270.51283	1852472.252	286726.9035	36010.016
16	4980	758.9803064	302.64812	1834310.073	481595.3382	30076.8
19	4980	845.8891281	133.25147	1904045.765	148904.0338	33000.034
20	4980	880.0535518	267.21051	2168177.885	1413346.799	36006.295
26	4980	652.2665957	334.84291	2622577.191	1164558.152	19593.588
28	4980	881.6246017	108.67237	3003551.984	908611.5231	40986.635
29	4980	899.4963542	86.24427	916725.2665	17140347.36	41000.008
38	4980	796.955452	81.07311	2859257.054	1143947.316	34988.03

45	4980	855.2947911	296.32603	568675.574	1095557.028	32000.027
50	4980	899.7763411	109.01968	2717912.609	980776.9019	34982.538
51	4980	809.8406493	89.24996	1877802.069	1187317.812	36018.774
53	4980	821.2647835	142.16719	1260432.856	742276.8836	37040.851
56	4980	881.2168917	91.5199	1963346.157	1087913.3	39000.006
57	4980	829.9489504	348.60847	423793.8165	814186.6582	31987.034
59	4980	863.0680526	96.86762	1413410.273	850216.2386	39015.521
60	4980	867.5814188	109.64986	2950464.135	919623.1987	35006.903
61	4980	867.1651196	293.62302	875838.3607	1871298.138	34018.289
63	4980	856.4700668	255.212	1810254.355	431837.8949	36075.27
65	4980	834.1078154	303.28205	1814490.099	489728.9245	26011.993
70	4980	874.1543062	88.4681	2056415.308	1074565.806	34996.176
71	4980	874.6199099	143.06149	1678597.745	322317.2686	36979.585
72	4980	877.4753299	84.54768	2364761.189	1195194.406	36999.993
73	4980	877.4600478	98.60438	2384245.45	875907.4326	36999.997
2	5040	862.0834134	97.32102	2012765.924	795102.9143	34993.875
6	5040	894.5093528	138.8969	1690938.105	770909.359	35222.172
7	5040	902.1701732	261.9115	528611.6363	1352697.067	35985.742
8	5040	740.8870185	273.04663	1955111.264	1376161.197	29789.086
12	5040	875.0273968	284.09665	1108050.881	1286600.204	36002.033
14	5040	865.9747849	270.39763	1793708.783	287082.3437	35979.794
16	5040	757.4588956	301.58995	1788680.779	502888.0731	30017.508
19	5040	845.8955979	133.43913	1946030.72	118300.7853	33000.029
20	5040	879.1665176	267.09694	2105689.795	1411070.041	36022.287
26	5040	629.6290425	334.80214	2601906.536	1197046.454	17597.703
28	5040	881.9977316	108.79731	3061546.989	893899.6521	41001.45
29	5040	899.4839724	86.41333	979574.3883	17201981.09	41000.034
38	5040	796.0920662	81.18804	2914904.295	1150370.559	34990.904
45	5040	855.2875405	296.31116	513798.7	1115685.506	32000.03
50	5040	899.0268464	109.20211	2777570.754	965371.7863	34996.421
51	5040	810.7575784	89.35884	1934881.822	1187827.717	35988.746
53	5040	819.940479	144.30112	1294265.929	707804.3835	36993.852
56	5040	881.208414	91.6349	2025245.051	1086646.603	39000.017
57	5040	828.469705	348.56991	412200.9766	857255.7237	31984.468
59	5040	871.1076919	97.01583	1473142.844	844763.3717	39006.032

60	5040	867.5569897	109.68714	3007800.764	904307.4676	35009.612
61	5040	868.1055855	293.4845	817343.3605	1889548.055	33997.106
63	5040	855.6881114	257.01589	1753332.452	421404.3923	35993.669
65	5040	834.5820083	303.12977	1764563.421	514581.9372	26007.282
70	5040	874.2451067	88.59035	2117916.819	1075733.751	34991.591
71	5040	874.0795687	133.64199	1716256.76	286031.0449	36997.718
72	5040	877.443427	84.63594	2426386.971	1199518.682	36999.993
73	5040	877.4341685	98.72205	2444456.45	869035.8186	37000.004
2	5100	862.0867599	97.43574	2072929.618	789247.3055	34990.421
6	5100	890.0831059	139.06541	1731263.771	735604.0155	35118.118
7	5100	901.5280997	261.52175	465394.498	1345877.87	35982.992
8	5100	771.4729643	272.94608	1900296.048	1378261.08	31778.749
12	5100	874.0983088	283.59613	1047862.174	1297513.835	36019.409
14	5100	865.8917928	270.29829	1734848.278	287344.8927	36003.209
16	5100	755.8640859	302.82584	1743626.553	524537.3506	29994.097
19	5100	845.8505323	133.52983	1988135.032	87427.35277	33000.134
20	5100	879.4480662	266.97743	2043226.599	1408700.739	36001.306
29	5100	899.4748254	86.5607	1042442.092	17255707.35	41000.028
38	5100	795.5903207	81.29571	2970525.518	1156706.872	35024.359
45	5100	855.3060576	296.23798	459088.3579	1135693.283	32000.029
50	5100	898.734366	109.43723	2837069.643	949796.2925	35018.504
51	5100	810.0580574	89.46538	1992496.722	1188262.657	35986.775
53	5100	817.4680052	143.24109	1327560.592	673310.3673	36999.348
56	5100	877.4504546	91.72168	2087189.965	1085300.164	38987.038
57	5100	828.0675724	348.54223	400567.323	900272.1851	31982.414
59	5100	876.0072393	97.11283	1533433.326	839158.8668	39000.285
61	5100	868.9340567	286.89186	757744.1721	1906068.311	34094.207
63	5100	854.7505457	256.47806	1696536.797	411265.5317	35998.872
65	5100	834.9633929	302.99077	1714046.117	539548.1083	25986.806
70	5100	874.2671933	88.70675	2179460.574	1076808.431	34987.021
71	5100	881.732023	114.76964	1766312.713	261555.9492	37058.834
72	5100	877.422679	84.81757	2488094.038	1203719.753	36999.995
73	5100	877.4297066	98.8358	2504914.901	862040.6316	37000.013
2	5160	862.0868714	97.55163	2132921.689	783313.5732	34829.899
6	5160	888.2148906	136.89575	1772678.833	701027.9673	35109.598

7	5160	900.7881981	261.68867	402223.7223	1339022.621	36000.479
8	5160	795.7951239	272.8377	1843108.567	1380375.82	32001.453
12	5160	873.7155857	282.98486	987509.1538	1307957.267	36017.438
14	5160	867.837869	274.45026	1675970.486	289446.7096	36054.897
16	5160	756.4074389	303.19185	1699204.975	546511.0992	29982.585
19	5160	839.5865229	133.60406	2029773.067	56780.24607	33018.048
20	5160	880.2697329	266.85688	1980767.948	1406236.709	35979.999
29	5160	899.4633359	86.69098	1105317.303	17303203.17	41000.024
38	5160	796.8951042	81.41002	3026209.781	1162967.531	34994.394
45	5160	855.2586494	296.12542	404045.5479	1155721.683	32000.012
50	5160	899.623185	109.62803	2896460.275	934041.3441	35000.617
51	5160	809.2938382	89.56997	2049600.247	1188614.82	36017.904
53	5160	817.058845	142.2102	1361753.312	639488.3098	37009.911
56	5160	869.5489123	91.84119	2148313.074	1083888.933	38986.265
57	5160	827.8879792	348.52032	388884.7705	943296.7122	31982.13
59	5160	878.5613667	119.40062	1592242.74	829209.072	39002.795
63	5160	853.3952307	255.40342	1640002.128	400418.4196	36015.673
65	5160	834.3748627	302.85636	1663838.362	564215.2771	25998.306
70	5160	874.265297	88.82622	2240990.181	1077789.499	34983.094
71	5160	878.6522788	108.08311	1822168.591	245498.4011	37059.455
72	5160	877.4381842	84.97613	2549723.641	1207777.725	37000.009
73	5160	877.4406383	98.94787	2565230.657	854968.7043	37000.026
2	5220	862.0817402	97.66448	2192960.726	777282.1819	34852.449
6	5220	889.7570495	134.83186	1815551.865	667862.4787	35184.583
7	5220	900.5044186	262.00442	339031.6824	1332400.173	36017.986
8	5220	796.4755701	272.72463	1785361.94	1382428.676	32000.055
12	5220	874.0308219	282.54219	926954.1061	1318000.516	36000.656
14	5220	867.2687482	276.34637	1617420.107	293863.9885	35980.522
16	5220	756.5283575	303.06806	1654534.473	568650.2268	29993.709
19	5220	836.8967525	128.40695	2071522.159	26660.18943	33001.133
20	5220	880.5211633	266.73744	1917754.649	1403654.413	35985.956
29	5220	899.4599894	86.81296	1168315.853	17347673.08	41000.018
38	5220	796.3369152	81.52246	3081821.195	1169131.986	34984.907
45	5220	855.3152045	296.06837	349151.068	1175593.551	32000.031
50	5220	899.6873254	109.64508	2955797.159	918227.4619	34981.99

51	5220	810.000833	89.67924	2106747.185	1188888.047	36016.877
53	5220	816.8446718	142.1857	1396345.848	605896.8847	37020.257
56	5220	867.5407036	91.97268	2209159.695	1082382.761	38999.418
57	5220	827.7538979	348.50027	377179.4257	986246.1074	31983.682
59	5220	879.7570557	134.37145	1639434.076	799979.8291	39001.81
63	5220	854.5740759	254.54037	1583693.608	388815.2052	35978.957
65	5220	834.2164637	302.70035	1613561.507	588753.5213	26013.438
70	5220	874.1579873	88.96523	2302544.853	1078669.879	34981.22
71	5220	876.4603496	107.36888	1878872.858	231857.5853	36982.956
72	5220	877.4523509	85.11293	2611534.745	1211729.581	37000.024
73	5220	877.4301527	99.0592	2625402.77	847821.5906	37000.034
2	5280	862.1153163	97.77565	2252977.489	771161.6962	34901.999
6	5280	890.063808	133.76501	1859275.457	635753.7298	35154.839
7	5280	901.3918989	262.08443	275240.0832	1325876.96	36003.564
8	5280	796.6812657	272.61281	1727746.371	1384393.7	32000.015
12	5280	874.3664715	282.30419	865829.7287	1327867.891	35989.368
14	5280	865.9484595	276.71897	1558923.804	299076.9565	36009.165
16	5280	756.2410085	302.75409	1609345.375	590816.9736	30004.255
19	5280	844.2813787	106.19144	2123114.763	8188.646553	33117.006
20	5280	880.0141751	266.62071	1855281.176	1400998.526	36009.88
29	5280	899.4679094	86.93114	1231231.56	17390757.63	41000.015
38	5280	795.528969	81.58609	3137622.018	1175259.273	35023.039
45	5280	855.241694	295.95596	293930.2657	1195502.779	32000.016
51	5280	810.8434708	89.79152	2163843.686	1189081.253	35984.928
53	5280	816.9052427	142.59576	1430666.818	572090.9202	37027.101
56	5280	866.6569044	92.10765	2270455.999	1080758.095	39018.586
57	5280	827.5856827	348.47992	365422.8723	1029226.202	31987.589
59	5280	878.5525544	135.36095	1682349.33	767452.4125	38999.952
63	5280	854.1036756	254.14222	1527154.073	376667.3214	36011.516
65	5280	834.9688587	302.71274	1563000.67	613342.2826	25999.365
70	5280	876.0660254	83.33498	2364037.506	1081743.974	35086.178
71	5280	874.0480004	108.76801	1935225.619	217724.3653	37023.431
72	5280	877.4353955	85.23747	2673163.09	1215565.269	37000.029
73	5280	877.43428	99.17307	2685487.331	840592.0738	37000.028
74	5280	871.9679544	81.43029	3037731.982	1164268.46	37004.537

75	5280	887.0078237	97.20566	1612101.041	955523.8612	35019.221
76	5280	944.550483	100.8875	2885099.985	813690.5517	35868.639
77	5280	877.5814126	100.50381	2632923.696	983688.3359	37000.013
78	5280	895.6105602	279.14546	572442.2097	1131546.234	37994.982
2	5340	862.0164843	97.88716	2313011.919	764948.6191	34822.184
6	5340	888.6669969	133.59648	1903606.81	603786.0821	35167.883
7	5340	901.6622926	261.93469	211948.3886	1319359.509	35983.052
8	5340	796.7215347	272.49973	1670165.556	1386274.667	32000.005
12	5340	874.9089322	282.18923	805124.2234	1337531.615	35980.074
14	5340	864.9517731	276.44185	1500258.94	304275.937	36020.181
16	5340	755.4623995	302.70429	1564693.119	612551.5419	30019.376
19	5340	841.7635046	97.66288	2179453.757	0	33116.485
20	5340	879.3127578	266.50285	1792821.554	1398247.513	36021.976
29	5340	899.4737099	87.0489	1294180.558	17433689.06	41000.013
45	5340	855.0995812	295.82896	238843.9724	1215236.841	32000.013
51	5340	809.9333461	89.90798	2221461.189	1189192.159	35993.087
53	5340	817.0317387	142.79346	1464471.889	538394.9431	37026.809
56	5340	866.5333086	88.90638	2331192.661	1079549.503	39055.639
57	5340	827.3579005	348.45866	353606.3492	1072264.961	31994.388
59	5340	874.5660319	134.69127	1725189.072	735186.4609	38999.503
63	5340	852.464358	257.32575	1471285.464	365096.6096	36060.258
65	5340	834.9046068	302.65417	1512502.989	637859.3005	25986.862
70	5340	876.6100477	80.05819	2425040.686	1088698.368	35077.709
71	5340	874.8985582	110.4265	1990957.878	202372.2864	36980.355
72	5340	877.0866947	85.35633	2734984.71	1219315.245	36999.961
73	5340	877.4346147	99.79584	2745790.399	833173.228	36999.999
74	5340	871.0099754	81.54042	3098470.576	1170976.932	37014.218
75	5340	887.2501071	97.04877	1673997.445	949785.1205	35019.664
77	5340	877.5799625	100.61634	2693008.583	975336.6338	37000.012
78	5340	896.5062951	279.028	509874.7791	1138952.15	37988.89

A3: Matlab Program for Intensity Calculations

```
datamatrix=[862.0164843	97.88716	2313011.919	764948.6191	34452.128
888.6669969	133.59648	1903606.81	603786.0821	35331.999
901.6622926	261.93469	211948.3886	1319359.509	35983.052
796.7215347	272.49973	1670165.556	1386274.667	32000.005
874.9089322	282.18923	805124.2234	1337531.615	35980.074
864.9517731	276.44185	1500258.94	304275.937	36020.181
755.4623995	302.70429	1564693.119	612551.5419	30019.376
841.7635046	97.66288	2179453.757	0	33116.485
879.3127578	266.50285	1792821.554	1398247.513	36021.976
899.4737099	87.0489	1294180.558	17433689.06	41000.013
855.0995812	295.82896	238843.9724	1215236.841	32000.013
809.9333461	89.90798	2221461.189	1189192.159	35993.087
817.0317387	142.79346	1464471.889	538394.9431	37026.809
866.5333086	88.90638	2331192.661	1079549.503	39055.639
827.3579005	348.45866	353606.3492	1072264.961	31994.388
874.5660319	134.69127	1725189.072	735186.4609	38999.503
852.464358	257.32575	1471285.464	365096.6096	36060.258
834.9046068	302.65417	1512502.989	637859.3005	25986.862
876.6100477	80.05819	2425040.686	1088698.368	35077.709
874.8985582	110.4265	1990957.878	202372.2864	36980.355
877.0866947	85.35633	2734984.71	1219315.245	36999.961
877.4346147	99.79584	2745790.399	833173.228	36999.999
871.0099754	81.54042	3098470.576	1170976.932	37014.218
887.2501071	97.04877	1673997.445	949785.1205	35019.664
877.5799625	100.61634	2693008.583	975336.6338	37000.012
```

```
896.5062951   279.028         509874.7791   1138952.15     37988.89];      %data      points
velocity (ft/sec), heading (deg), x location (ft), y location (ft)
psivct=[-90, -45, 0, 15, 30, 45, 90];%degrees degrees of error
psidot=3; %degrees/sec rate of error change
d=500; %distance apart for a problem, in feet
Nr_AC=size(datamatrix,1); %number of aircraft in sector

for c1 = 1:size(psivct,2)
   psi1=psivct(c1); %for loop to run through array of blunder errors


c = combnk(1:Nr_AC,2)
for n=1:size(c,1);

k1=datamatrix(c(n,1),1).*cosd(datamatrix(c(n,1),2)+psi1)-
datamatrix(c(n,2),1)*cosd(datamatrix(c(n,2),2));

k2=((datamatrix(c(n,1),1)/psidot).*(sind(datamatrix(c(n,1),2)+psi1)-
sind(datamatrix(c(n,1),2))))-
cosd(datamatrix(c(n,1),2)+psi1)*datamatrix(c(n,1),1).*(psi1./psidot)+datamatrix(c(n,1),3
)-datamatrix(c(n,2),3);

k3=datamatrix(c(n,1),1).*sind(datamatrix(c(n,1),2)+psi1)-
datamatrix((c(n,2)),1)*sind(datamatrix((c(n,2)),2));

k4=(datamatrix(c(n,1),1)/psidot)*(cosd(datamatrix(c(n,1),2))-
cosd(datamatrix(c(n,1),2)+psi1))-
sind(datamatrix(c(n,1),2)+psi1)*datamatrix(c(n,1),1).*(psi1./psidot)+datamatrix(c(n,1),4)
-datamatrix(c(n,2),4);
```

```
k5=k1.^2+k3.^2; %"a" in the polynomial
k6=2*(k1.*k2+k3.*k4); %"b" in the polynomial
k7=k3.^2+k4.^2-500; %"c" in the polynomial
p = [k5 k6 k7]; % creating hte polynomial
r = roots(p); %solving for roots
if(~isempty(r))
   rr(:,c1,n)=real(r)/60; %getting real answers

distance=((datamatrix(c(n,2),3)-
datamatrix(c(n,1),3)).^2+(datamatrix(c(n,2),4)+datamatrix(c(n,1),4))).^(1/2);
vertdistance=abs(datamatrix(c(n,1),5)-datamatrix(c(n,2),5));
if(~isempty(distance))
   dist(:,n)=real(distance);
if(~isempty(vertdistance));
   vert(:,n)=real(vertdistance);
end;
end;
end;
end;
end;

a=size(psivct,2)
b=size(c,1)
output=reshape(rr, [a 2 b])
pairs=c.';

filename='IntensityOutput_time.csv';
csvwrite(filename,output);
dlmwrite(filename, pairs, '-append');
dlmwrite(filename, psivct, '-append');
```

dlmwrite(filename, dist, '-append');

dlmwrite(filename, vert, '-append');

A4: Sample Matlab Output (all matlab outputs available upon request)

IntensityOutput_time.csv

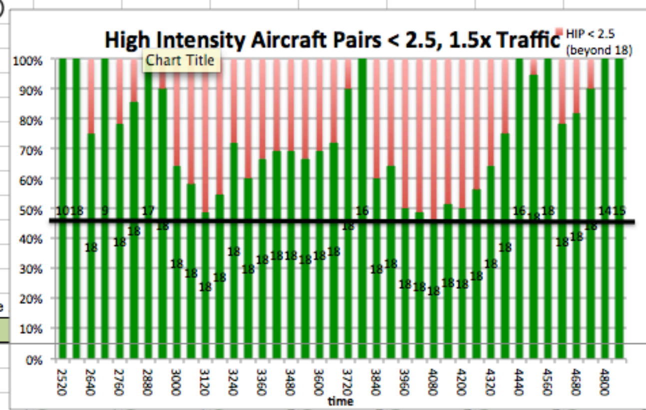
	A	B	C	D	E	F	G	H	I	J
	VarName1	VarName2	VarName3	VarName4	VarName5	VarName6	VarName7	VarName8	VarName9	VarName...
	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
1	-7.1386	-1.548	-23.89	2.1795	0.19638	3.3868	-5.634	1.7547	-21.937	-2.3007
2	-0.43326	-156.42	-1.7811	20.246	0.19638	14.153	-5.634	21.378	-1.7824	-1.1259
3	-11.918	-5.1005	-2.8789	1.638	4.0428	3.099	2.4032	1.5203	-11.931	-1.1259
4	-0.53181	76.4	-2.8789	27.137	4.0428	16.211	2.4032	25.275	-2.0062	0.13578
5	-26.334	4.1198	5.1959	1.3992	9.5511	3.0076	13.672	1.395	-3.4334	0.13578
6	-0.9488	10.949	5.1959	56.952	4.0897	23.39	2.2111	39.959	-3.4334	5.1898
7	-44.511	1.0811	13.751	1.31	12.029	3.6263	17.591	1.3868	-2.3007	5.1898
8	1	1	1	1	1	1	1	1	1	1
9	2	3	4	5	6	7	8	9	10	11
10	-90	-45	0	15	30	45	90			
11	4.0941e...	2.1011e...	6.4285e...	1.5079e...	8.1275e...	7.4832e...	1.3356e...	5.2019e...	1.0188e...	2.0742e...
12	879.87	1530.9	2452.1	1527.9	1568.1	4432.8	1335.6	1569.8	6547.9	2452.1

A5: Sample Excel Analysis Output (all output analysis available upon request)

19.331	1.7174	−40.243	45.235	−32.359	0.48429	−21.117	40.736	−3.6012	−21.039
0.90214	0.67784	−4.88E+00	28.693	−0.21259	106.68	−3.3047	14.605	−3.6012	−10.835
10.66	0.67784	−72.38	28.693	−85.955	0.28096	−30.909	14.605	−2.0002	−10.835
0.95182	−0.44924	−10.111	16.122	−0.34182	73.987	−6.7767	6.636	−2.0002	−8.2225
2.7129	−0.44924	490.58	16.122	494.23	0.20561	−261.29	6.636	−75.507	−8.2225
2.7129	−7.5143	156.94	1.457	1.754	34.283	−88.797	−1.2821	−75.507	−5.7612
1.7174	−2.6725	75.388	1.46E+00	182.79	0.16622	40.736	−1.2821	−21.039	−5.7612
1	1	1	1	1	1	1	1	1	1
2	3	4	5	6	7	8	9	10	11
−90	−45	0	15	30	45	90			
8.40E+05	1.21E+06	1.80E+06	6.50E+05	8.10E+04	1.20E+06	1.18E+06	3.00E+05	6.67E+05	6.55E+05
3.33E+03	1.29E+03	2.57E+03	5.44E+02	2.54E+03	3.42E+03	7.66E+03	2.44E+03	6.61E+03	1.54E+03
1	2	1	3	1	4	1	5	1	6
Min(>0)	1.7174		45.235		0.48429		40.736		0
	0.67784		28.693		106.68		14.605		0
	0.67784		28.693		0.28096		14.605		0
	0.95182		16.122		73.987		6.636		0
	2.7129		16.122		0.20561		6.636		0
	2.7129		1.457		1.754		0		0
	1.7174		1.457		0.16622		40.736		0
min	0.67784		1.457		0.16622		6.636		0
median	1.7174		16.122		0.48429		14.605		#NUM!
distance	840,200.00		1,207,400.00		#########		650,370.00		80,960.00
vertical	3,327.70		1,292.00		2,565.80		543.68		2,540.20
High Intensity			1						
Count	10								
High Intensity									
Count	6								
High Intensity			1						
Count	11								

A6: Sample Excel Analysis of #HIP/minute and Safety Threshold Percentages

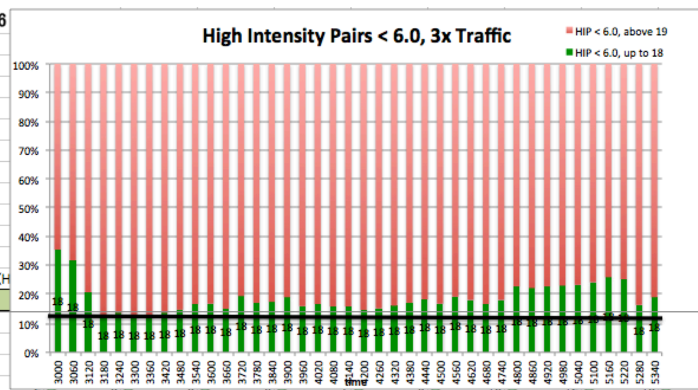
Analysis two (1.5x, 18 aircraft max)



Number of High Intensity Pairs(HIP) per Minute

(time)	(HIP)	1%									10%	11%
2520	10	1									1	2
2580	18	1									2	2
2640	24	1									3	3
2700	9	1	1	1	1	1	1	1	1	1	1	1
2760	23	1	1	1	1	2	2	2	2	3	3	3
2820	21	1	1	1	1	2	2	2	2	2	3	3
2880	17	1	1	1	1	1	2	2	2	2	2	2
2940	20	1	1	1	1	1	2	2	2	2	2	3
3000	28	1	1	1	2	2	2	2	3	3	3	4
3060	31	1	1	1	2	2	2	3	3	3	4	4
3120	37	1	1	2	2	2	3	3	3	4	4	5
3180	33	1	1	1	2	2	2	3	3	3	4	4
3240	25	1	1	1	1	2	2	2	2	3	3	3
3300	30	1	1	1	2	2	2	3	3	3	3	4

Analysis Three (3.0x, 36



Notes:
Times with HIP>18 tend t
Intervening with xx% of HI
Itervening with 100% of HI
Intervening with 90% of HI
Intervening with 60% of HI

HIP Definition
Intensity <= 2.5
Verticle distance betweer
(this presents the most ri
(HIP with verticle distanc

Number of High Intensity Pairs(H

(time)	(HIP)										10%	11%	12%	13%
3000	51										6	6	7	7
3060	57										6	7	7	8
3120	88										9	10	11	12
3180	139										14	16	17	19
3240	131	2	3	4	6	7	8	10	11	12	14	15	16	18
3300	142	2	3	5	6	8	9	10	12	13	15	16	18	19
3360	139	2	3	5	6	7	9	10	12	13	14	16	17	19
3420	131	2	3	4	6	7	8	10	11	12	14	15	16	18
3480	125	2	3	4	5	7	8	9	10	12	13	14	15	17
3540	110	2	3	4	5	6	7	8	9	10	11	13	14	15
3600	109	2	3	4	5	6	7	8	9	10	11	12	14	15

Appendix B: Analysis of Results

B1: Percentage of Safe Intervention with respect to Traffic Level Regression

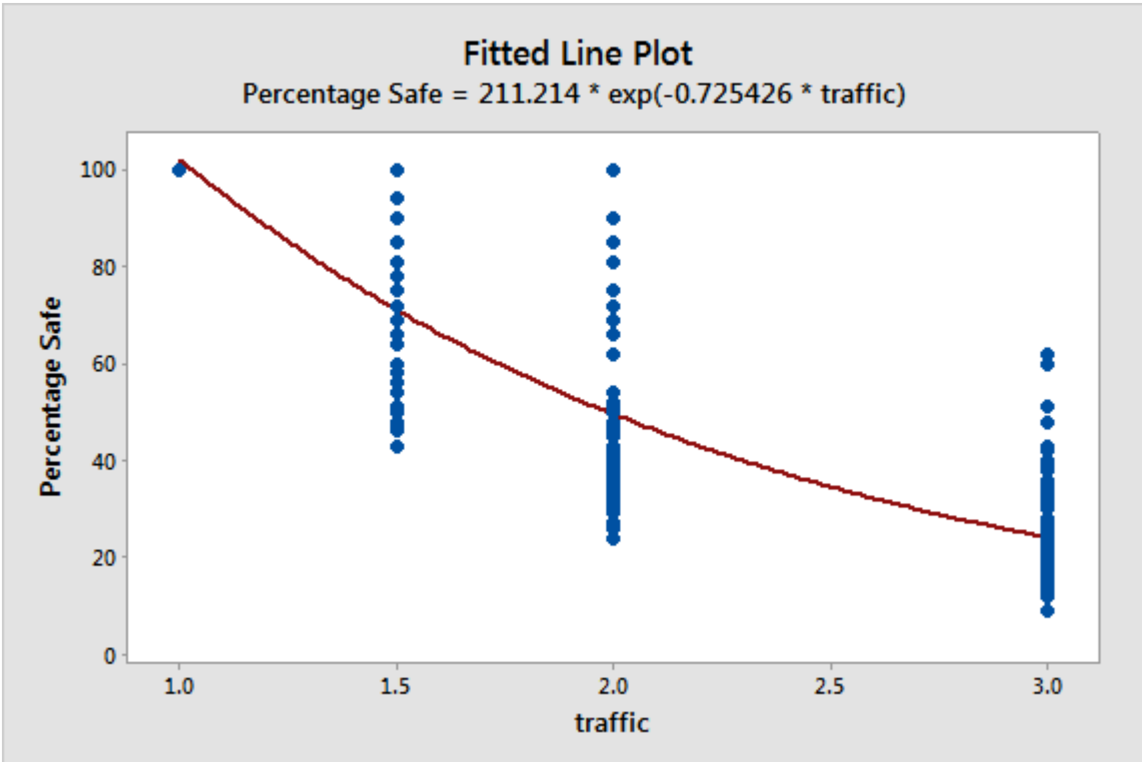
Nonlinear Regression: Percentage Safe = Theta1 * exp(Theta2 * traffic)

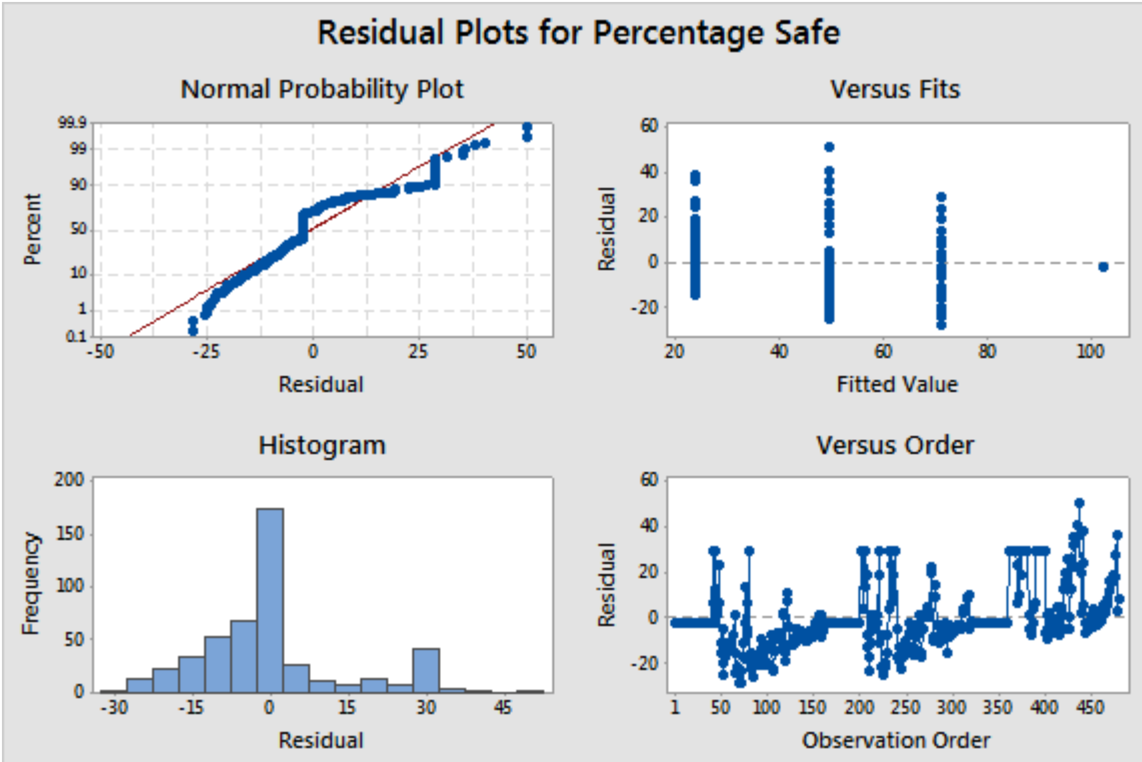
```
Method

Algorithm        Gauss-Newton
Max iterations            200
Tolerance             0.00001


Starting Values for Parameters

Parameter  Value
Theta1      3.22
Theta2     -1.18


Equation

Percentage Safe = 211.214 * exp(-0.725426 * traffic)


Parameter Estimates

Parameter  Estimate  SE Estimate
Theta1      211.214      5.98265
Theta2       -0.725      0.02010

Percentage Safe = Theta1 * exp(Theta2 * traffic)


Lack of Fit

Source          DF       SS       MS      F      P
Error          478  92403.5   193.31
  Lack of Fit    2   6530.8  3265.40  18.10  0.000
  Pure Error   476  85872.7   180.40


Summary

Iterations       10
Final SSE   92403.5
DFE             478
MSE         193.313
S           13.9037
```

Descriptive Statistics: Percentage Safe

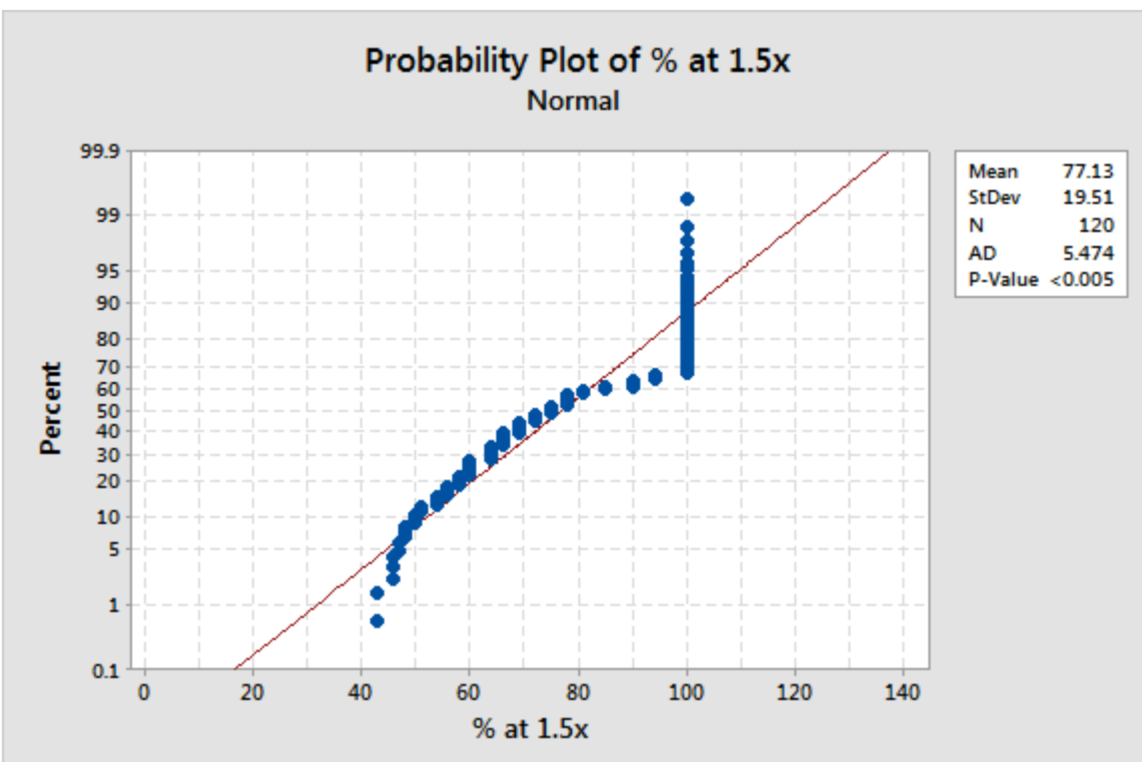
```
Variabltraffic N  N*    Mean   SE Mean     StDev  Minimum      Q1  Mediange
       1.0      120   0  100.00  0.000000  0.000000   100.00  100.00  100.00
       1.5      120   0   77.13      1.78     19.51    43.00   60.00   75.00
       2.0      120   0   45.90      1.45     15.85    24.00   35.25   42.00
```

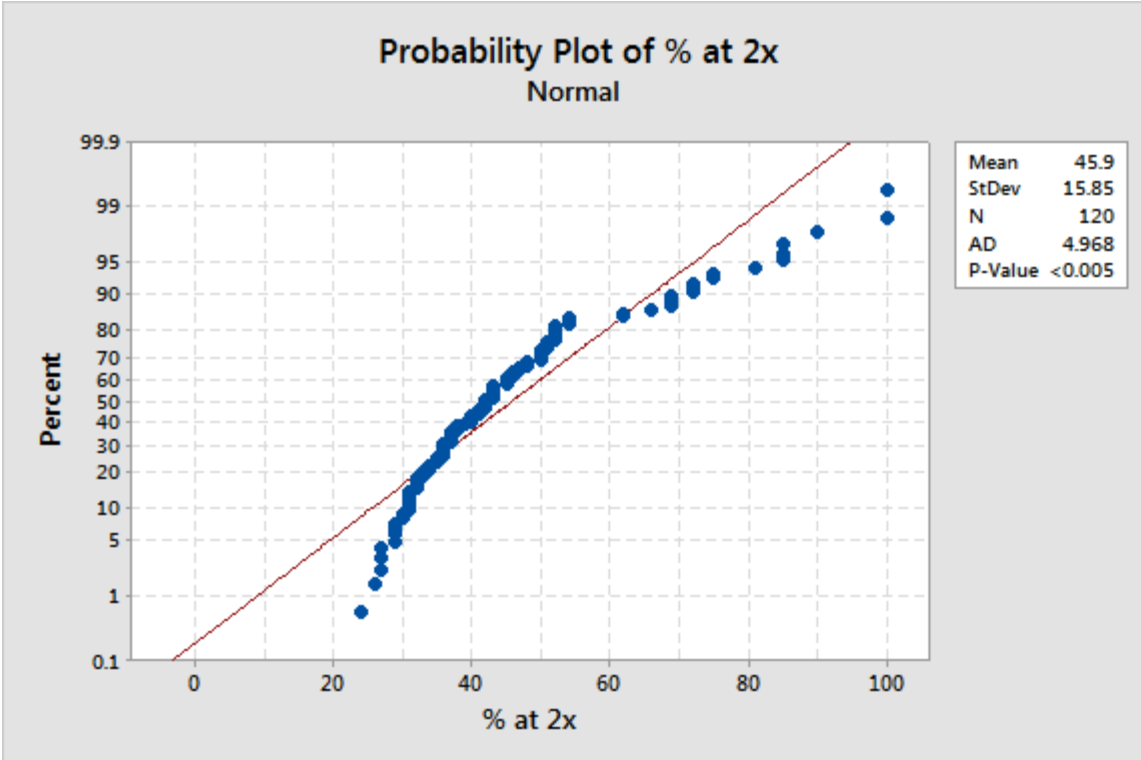
```
       3.0       120    0   23.242      0.866      9.482     9.000  17.000   21.000

Variable          traffic        Q3   Maximum
Percentage Safe   1.0        100.00    100.00
                  1.5        100.00    100.00
                  2.0         51.00    100.00
                  3.0        27.000    62.000
```

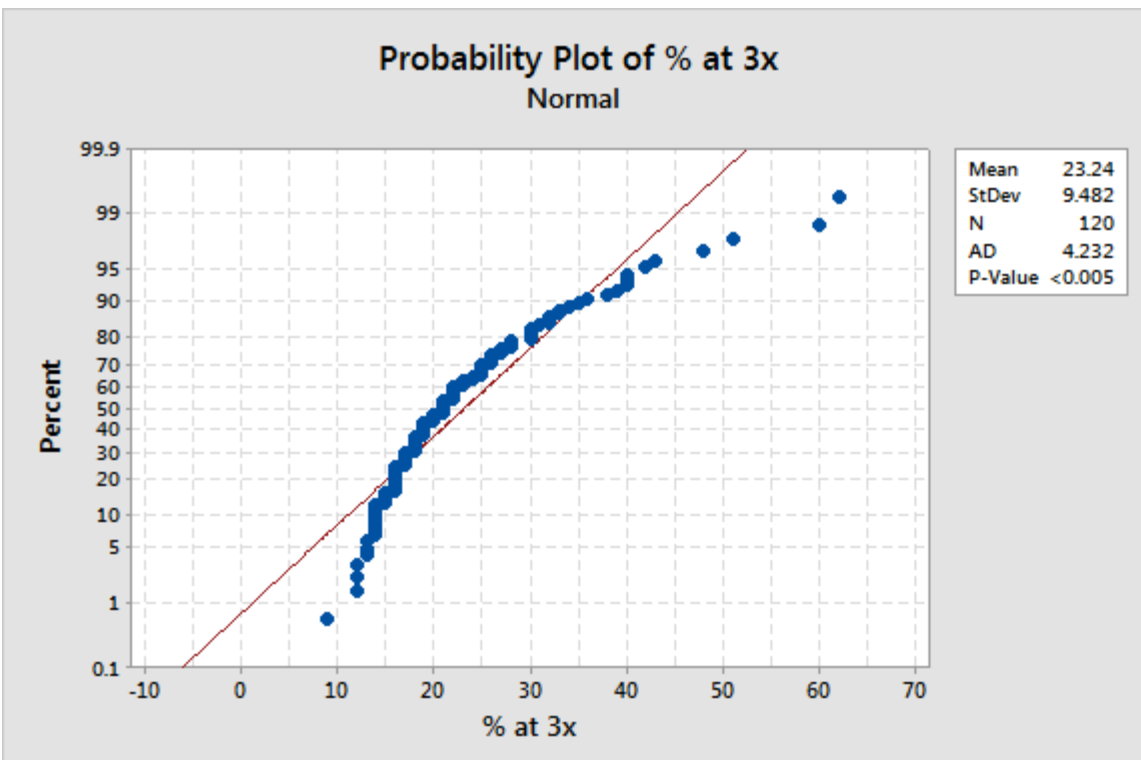




B2: Normality of Safe Intervention Level and CI




Probability Plot of % at 2x
Normal
Percent
% at 2x
Mean 45.9
StDev 15.85
N 120
AD 4.968
P-Value <0.005


Probability Plot of % at 3x
Normal
Percent
% at 3x
Mean 23.24
StDev 9.482
N 120
AD 4.232
P-Value <0.005

One-Sample T: % at 1.5x, % at 2x, % at 3x

Variable	N	Mean	StDev	SE Mean	95% CI
% at 1.5x	120	77.13	19.51	1.78	(73.61, 80.66)
% at 2x	120	45.90	15.85	1.45	(43.04, 48.76)
% at 3x	120	23.242	9.482	0.866	(21.528, 24.956)

				Confidence Interval		
	N	Median	Achieved Confidence	Lower	Upper	Position
% at 1.5x	120	75.00	0.9448	69.00	81.00	50
			0.9500	69.00	81.81	NLI
			0.9642	69.00	85.00	49
% at 2x	120	42.00	0.9448	40.00	45.00	50
			0.9500	40.00	45.00	NLI
			0.9642	40.00	45.00	49
% at 3x	120	21.00	0.9448	19.00	22.00	50
			0.9500	19.00	22.00	NLI
			0.9642	19.00	22.00	49

[69

B3: Non-Linear Regression Analysis of HIP/min and Traffic Level (Power)

Nonlinear Regression: HIP = Theta1 * traffic ^ Theta2

Method

Algorithm	Gauss-Newton
Max iterations	200
Tolerance	0.00001

Starting Values for Parameters

Parameter	Value
Theta1	6.32
Theta2	2.55

Equation

HIP = 10.4239 * traffic ^ 1.91876

Parameter Estimates

Parameter	Estimate	SE Estimate
Theta1	10.4239	0.655037
Theta2	1.9188	0.062263

HIP = Theta1 * traffic ^ Theta2

Lack of Fit

```
Source          DF      SS       MS      F      P
Error          478  112447   235.24
  Lack of Fit    2    4564  2281.89  10.07  0.000
  Pure Error   476  107883   226.64


Summary

Iterations        8
Final SSE    112447
DFE             478
MSE         235.244
S           15.3377
```

B4: Non-Linear Regression Analysis of HIP/min and Traffic Level (weighted power)

Nonlinear Regression: HIP/min = Theta1 * Traffic ^ Theta2

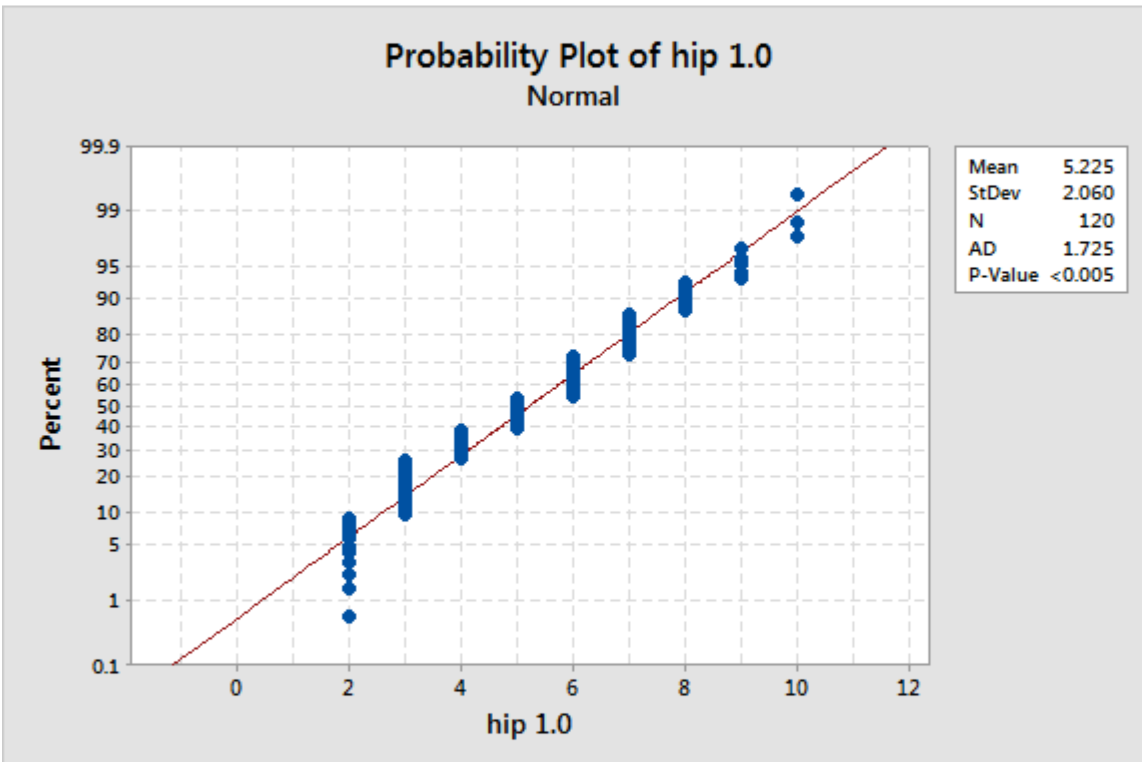
```
Method

Weights            1/response
Algorithm        Gauss-Newton
Max iterations            200
Tolerance             0.00001


Starting Values for Parameters

Parameter  Value
Theta1      10.4
Theta2      1.91


Equation

HIP/min = 6.63144 * Traffic ^ 2.26349


Parameter Estimates

Parameter  Estimate  SE Estimate
Theta1      6.63144     0.324176
Theta2      2.26349     0.052593

HIP/min = Theta1 * Traffic ^ Theta2


Lack of Fit

Source          DF       SS       MS      F      P
Error          478  2533.54    5.300
  Lack of Fit    2   358.10  179.052  39.18  0.000
  Pure Error   476  2175.43    4.570


Summary
```

```
Iterations         9
Final SSE    2533.54
DFE              478
MSE          5.30028
S            2.30223
```

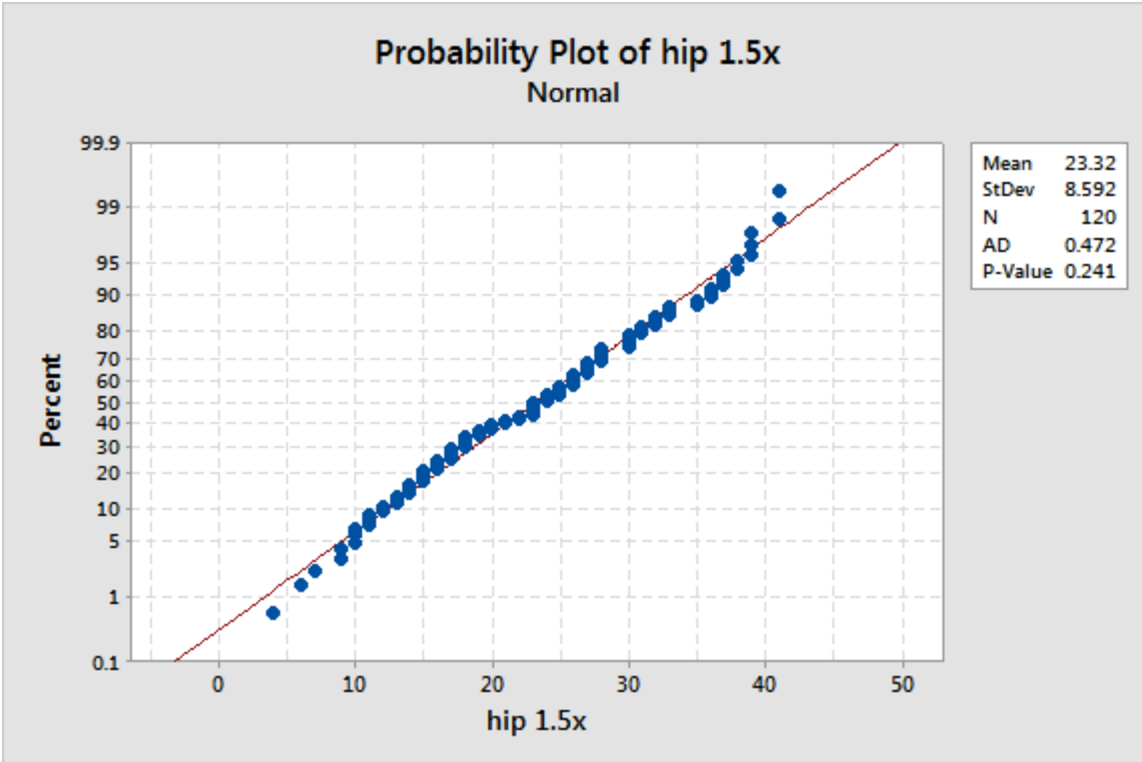
Fitted Line: HIP/min versus Traffic

Residual Plots for HIP/min

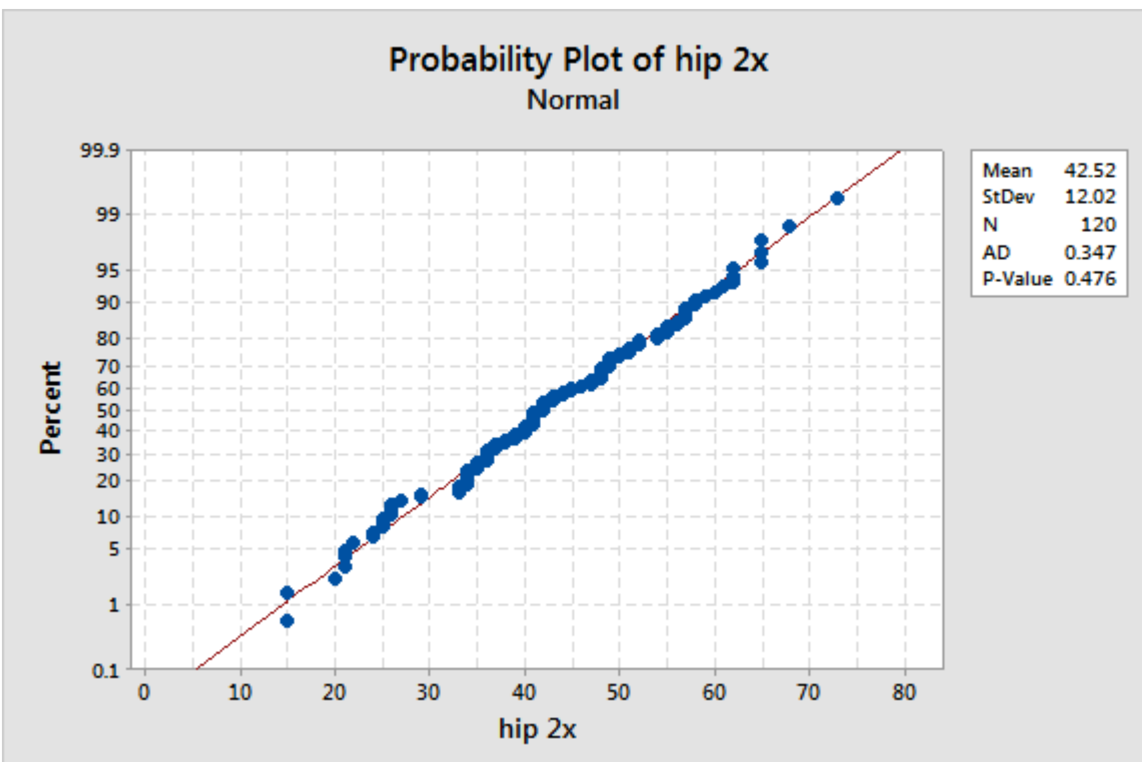
B5: Normality and CI for hip/min



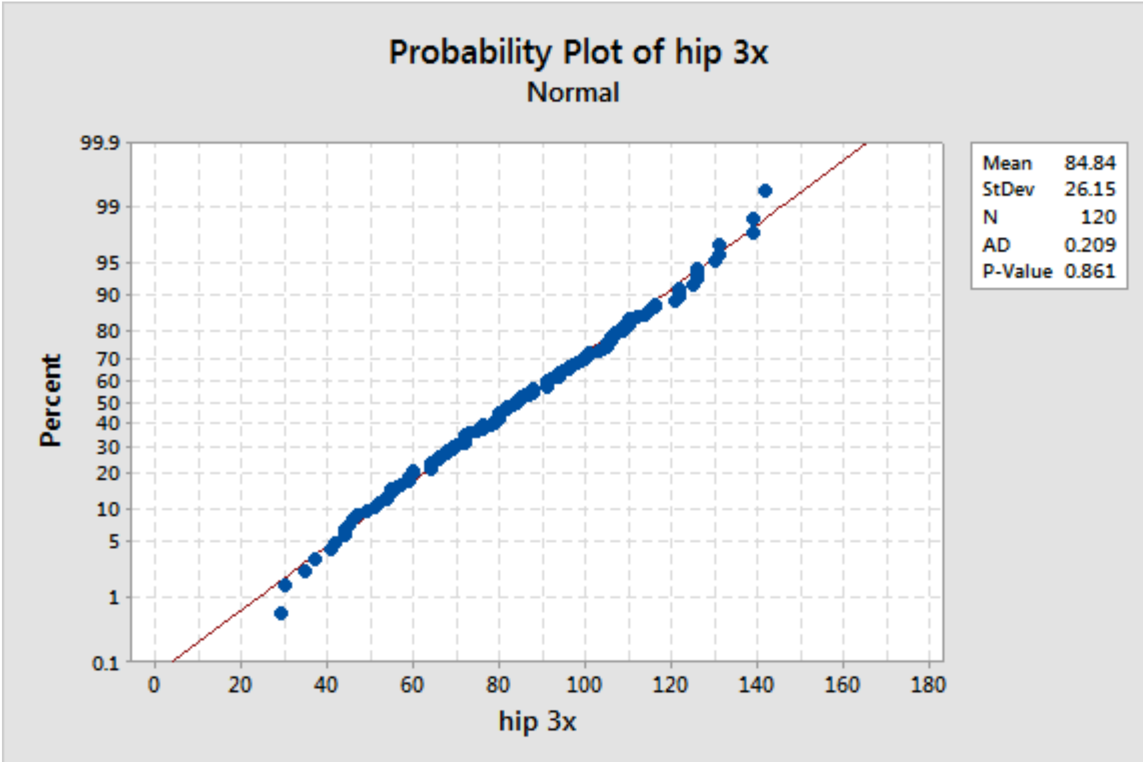
1.5x


Probability Plot of hip 1.5x
Normal
Percent
hip 1.5x
Mean 23.32
StDev 8.592
N 120
AD 0.472
P-Value 0.241

2x


Probability Plot of hip 2x
Normal
Percent
hip 2x
Mean 42.52
StDev 12.02
N 120
AD 0.347
P-Value 0.476

3x



Sign confidence interval for median

	N	Median	Achieved Confidence	Confidence Interval Lower	Confidence Interval Upper	Position
hip 1.0	120	5.000	0.9448	5.000	6.000	50
			0.9500	5.000	6.000	NLI
			0.9642	5.000	6.000	49
hip 1.5x	120	23.50	0.9448	21.00	26.00	50
			0.9500	21.00	26.00	NLI
			0.9642	21.00	26.00	49
hip 2x	120	42.00	0.9448	40.00	45.00	50
			0.9500	40.00	45.00	NLI
			0.9642	40.00	45.00	49
hip 3x	120	84.00	0.9448	79.00	91.00	50
			0.9500	79.00	91.00	NLI
			0.9642	79.00	91.00	49

B6: Linear Regression for HIP/min and Traffic Level

Regression Analysis: HIP versus traffic

Method

Categorical predictor coding (1, 0)

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	420072	140024	617.81	0.000
traffic	3	420072	140024	617.81	0.000
Error	476	107883	227		
Total	479	527955			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
15.0547	79.57%	79.44%	79.22%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	5.23	1.37	3.80	0.000	
traffic					
1.5	18.09	1.94	9.31	0.000	1.50
2.0	37.30	1.94	19.19	0.000	1.50
3.0	79.62	1.94	40.96	0.000	1.50

Regression Equation

HIP = 5.23 +†0.0†traffic_1.0 +†18.09†traffic_1.5 +†37.30†traffic_2.0
+†79.62†traffic_3.0

Fits and Diagnostics for Unusual Observations

Obs	HIP	Fit	Resid	Std Resid	
84	73.00	42.53	30.47	2.03	R
121	51.00	84.84	-33.84	-2.26	R
124	139.00	84.84	54.16	3.61	R
125	131.00	84.84	46.16	3.08	R
126	142.00	84.84	57.16	3.81	R
127	139.00	84.84	54.16	3.61	R
128	131.00	84.84	46.16	3.08	R
129	125.00	84.84	40.16	2.68	R
132	122.00	84.84	37.16	2.48	R
137	115.00	84.84	30.16	2.01	R
139	116.00	84.84	31.16	2.08	R
140	116.00	84.84	31.16	2.08	R
141	126.00	84.84	41.16	2.75	R
142	121.00	84.84	36.16	2.41	R
281	47.00	84.84	-37.84	-2.52	R
282	54.00	84.84	-30.84	-2.06	R
284	126.00	84.84	41.16	2.75	R

285	122.00	84.84	37.16	2.48	R
286	130.00	84.84	45.16	3.01	R
287	126.00	84.84	41.16	2.75	R
288	122.00	84.84	37.16	2.48	R
317	54.00	84.84	-30.84	-2.06	R
318	52.00	84.84	-32.84	-2.19	R
441	29.00	84.84	-55.84	-3.72	R
442	37.00	84.84	-47.84	-3.19	R
470	49.00	84.84	-35.84	-2.39	R
471	44.00	84.84	-40.84	-2.72	R
472	45.00	84.84	-39.84	-2.66	R
473	46.00	84.84	-38.84	-2.59	R
474	44.00	84.84	-40.84	-2.72	R
475	41.00	84.84	-43.84	-2.92	R
476	42.00	84.84	-42.84	-2.86	R
477	35.00	84.84	-49.84	-3.32	R
478	30.00	84.84	-54.84	-3.66	R

R Large residual

B7: Linear Regression for HIP/min and Traffic Level (weighted)

Regression Analysis: HIP/min versus Traffic

Method

Categorical predictor coding	(1, 0)
Weights	1/response

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	3	10563	3520.88	770.39	0.000
Traffic	3	10563	3520.88	770.39	0.000
Error	476	2175	4.57		
Total	479	12738			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.13781	82.92%	82.81%	82.53%

Coefficients

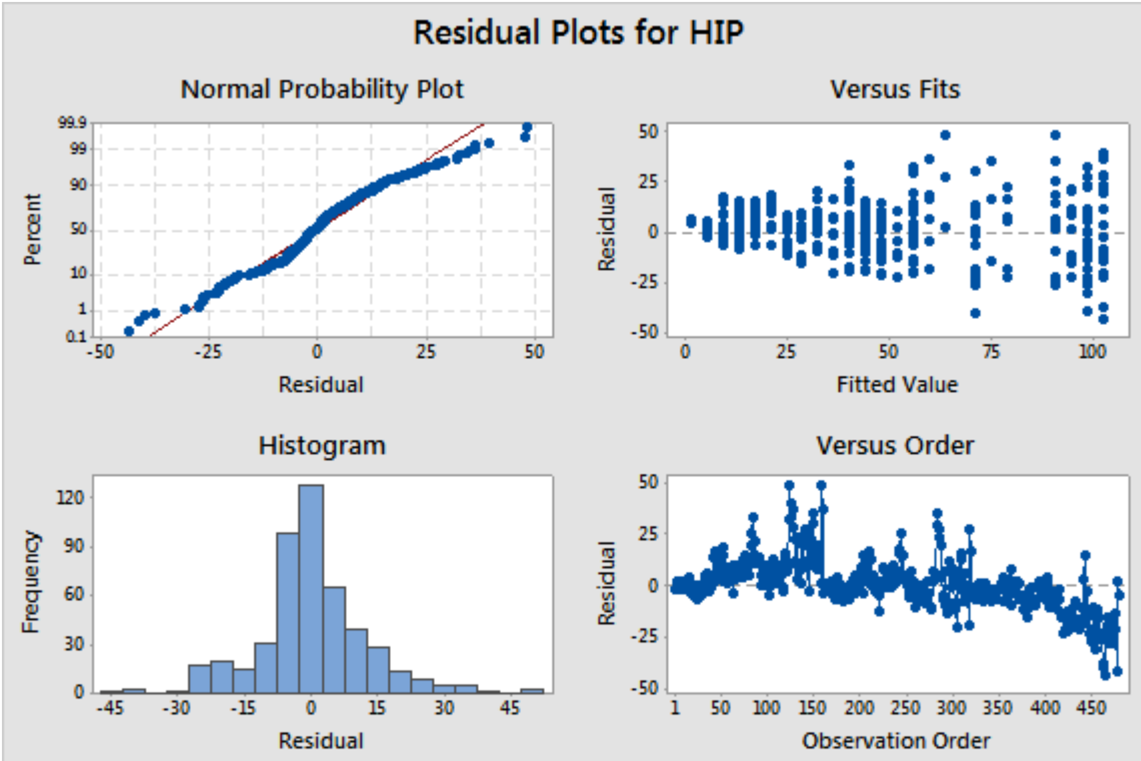
Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	4.337	0.406	10.67	0.000	
Traffic					
1.5	14.956	0.949	15.77	0.000	1.03
2.0	34.22	1.28	26.77	0.000	1.02
3.0	71.25	1.74	40.84	0.000	1.01

Regression Equation

```
HIP/min = 4.337 +†0.0†Traffic_1.0 +†14.956†Traffic_1.5 +†34.22†Traffic_2.0
          +†71.25†Traffic_3.0


Fits and Diagnostics for Unusual Observations

Obs  HIP/min    Fit   Resid  Std Resid
124   139.00  75.59   63.41       2.52  R
125   131.00  75.59   55.41       2.27  R
126   142.00  75.59   66.41       2.61  R
127   139.00  75.59   63.41       2.52  R
128   131.00  75.59   55.41       2.27  R
129   125.00  75.59   49.41       2.07  R
141   126.00  75.59   50.41       2.11  R
284   126.00  75.59   50.41       2.11  R
286   130.00  75.59   54.41       2.24  R
287   126.00  75.59   50.41       2.11  R
361     6.00  19.29  -13.29      -2.57  R  X
364     4.00  19.29  -15.29      -3.65  R  X
400     7.00  19.29  -12.29      -2.20  R
437    15.00  38.56  -23.56      -2.88  R
438    15.00  38.56  -23.56      -2.88  R
441    29.00  75.59  -46.59      -4.09  R
442    37.00  75.59  -38.59      -2.99  R
471    44.00  75.59  -31.59      -2.24  R
472    45.00  75.59  -30.59      -2.15  R
473    46.00  75.59  -29.59      -2.06  R
474    44.00  75.59  -31.59      -2.24  R
475    41.00  75.59  -34.59      -2.55  R
476    42.00  75.59  -33.59      -2.44  R
477    35.00  75.59  -40.59      -3.24  R
478    30.00  75.59  -45.59      -3.94  R

R  Large residual
X  Unusual X
```

Residual Plots for HIP/min

B8: HIP/minute by n/minute Regression



Regression Analysis: HIP versus n

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	453458	226729	1451.74	0.000
n	1	11306	11306	72.39	0.000
n*n	1	1	1	0.00	0.950
Error	477	74497	156		
Lack-of-Fit	21	7634	364	2.48	0.000
Pure Error	456	66863	147		
Total	479	527955			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
12.4971	85.89%	85.83%	85.64%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-37.24	4.63	-8.04	0.000	

n	3.860	0.454	8.51	0.000	39.53
n*n	0.00062	0.00988	0.06	0.950	39.53

Regression Equation

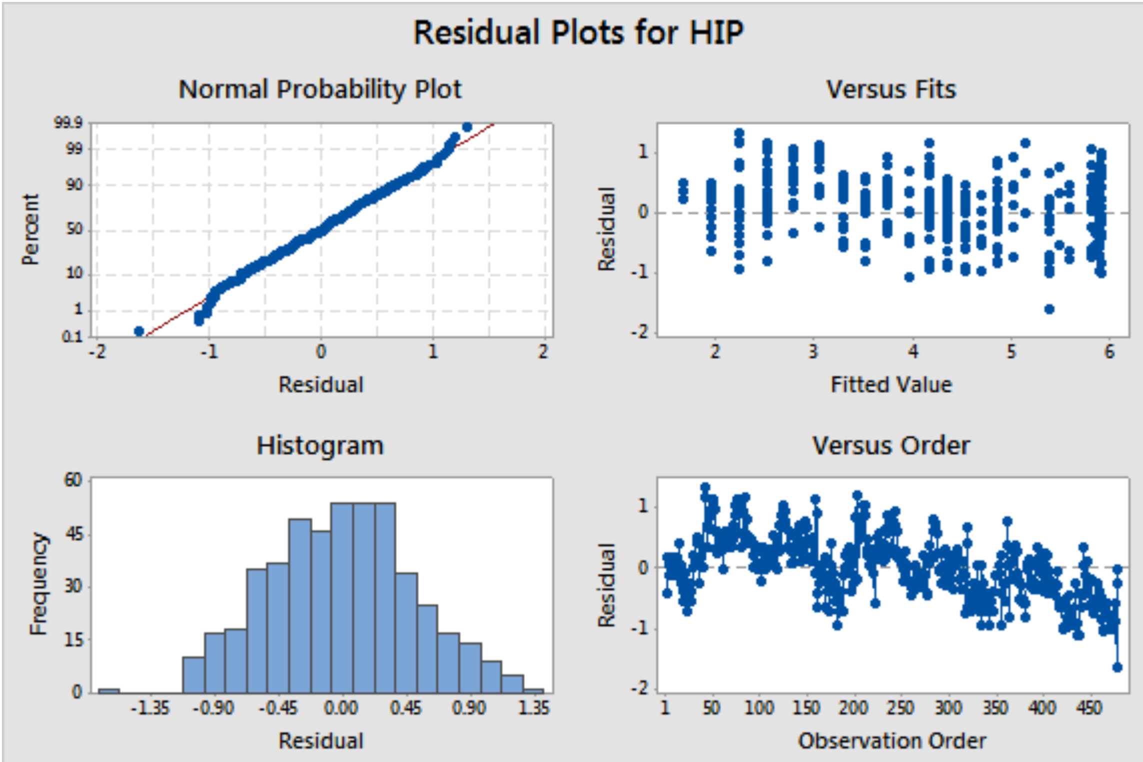
HIP = -37.24 +†3.860†n +†0.00062†n*n

Fits and Diagnostics for Unusual Observations

Obs	HIP	Fit	Resid	Std Resid	
84	73.00	40.20	32.80	2.63	R
123	88.00	55.75	32.25	2.59	R
124	139.00	90.80	48.20	3.87	R
125	131.00	98.60	32.40	2.61	R
126	142.00	102.51	39.49	3.19	R
127	139.00	102.51	36.49	2.95	R
128	131.00	102.51	28.49	2.30	R
140	116.00	90.80	25.20	2.03	R
141	126.00	98.60	27.40	2.21	R
149	110.00	75.21	34.79	2.79	R
150	101.00	71.31	29.69	2.38	R
159	112.00	63.53	48.47	3.89	R
160	96.00	59.64	36.36	2.92	R
283	85.00	55.75	29.25	2.35	R
284	126.00	90.80	35.20	2.83	R
286	130.00	102.51	27.49	2.22	R
319	91.00	63.53	27.47	2.20	R
450	72.00	98.60	-26.60	-2.14	R
451	72.00	98.60	-26.60	-2.14	R
453	64.00	90.80	-26.80	-2.15	R
454	68.00	98.60	-30.60	-2.47	R
455	72.00	98.60	-26.60	-2.14	R
462	73.00	98.60	-25.60	-2.06	R
463	65.00	102.51	-37.51	-3.03	R
464	59.00	98.60	-39.60	-3.19	R
465	59.00	102.51	-43.51	-3.51	R
471	44.00	71.31	-27.31	-2.19	R
472	45.00	71.31	-26.31	-2.11	R
473	46.00	71.31	-25.31	-2.03	R
474	44.00	71.31	-27.31	-2.19	R
478	30.00	71.31	-41.31	-3.32	R

R Large residual

B9: Box-Cox Regression



Regression Analysis: HIP versus n

Method

Box-Cox transformation	
Rounded λ	0.390046
Estimated λ	0.390046
95% CI for λ	(0.329546, 0.451546)

Analysis of Variance for Transformed Response

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	2	891.63	445.814	1741.84	0.000
n	1	129.50	129.500	505.97	0.000
n*n	1	46.84	46.840	183.01	0.000
Error	477	122.09	0.256		
Lack-of-Fit	21	25.53	1.216	5.74	0.000
Pure Error	456	96.55	0.212		
Total	479	1013.71			

Model Summary for Transformed Response

S	R-sq	R-sq(adj)	R-sq(pred)
0.505909	87.96%	87.91%	87.81%

Coefficients for Transformed Response

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-1.925	0.187	-10.27	0.000	
n	0.4131	0.0184	22.49	0.000	39.53
n*n	-0.005409	0.000400	-13.53	0.000	39.53

Regression Equation

HIP^0.390046 = -1.925 +†0.4131†n -†0.005409†n*n

Fits and Diagnostics for Unusual Observations

Original Response

Obs	HIP	Fit
42	23.000	8.022
43	26.000	8.022
50	32.000	13.978
51	39.000	17.499
74	26.000	10.808
76	28.000	10.808
77	27.000	10.808
78	26.000	10.808
84	73.000	38.952
124	139.000	91.230
159	112.000	67.079
203	24.000	8.022
210	31.000	13.978
211	37.000	17.499
437	15.000	34.296
438	15.000	34.296
465	59.000	96.110
471	44.000	75.442
474	44.000	75.442
478	30.000	75.442

Transformed Response

Obs	HIP'	Fit	Resid	Std Resid	
42	3.3973	2.2527	1.1446	2.27	R
43	3.5637	2.2527	1.3110	2.60	R
50	3.8644	2.7975	1.0668	2.11	R
51	4.1743	3.0537	1.1206	2.22	R
74	3.5637	2.5305	1.0332	2.05	R
76	3.6682	2.5305	1.1377	2.25	R
77	3.6166	2.5305	1.0860	2.15	R
78	3.5637	2.5305	1.0332	2.05	R
84	5.3307	4.1723	1.1583	2.29	R
124	6.8529	5.8149	1.0380	2.06	R
159	6.2993	5.1576	1.1416	2.26	R
203	3.4542	2.2527	1.2015	2.38	R
210	3.8168	2.7975	1.0193	2.02	R
211	4.0895	3.0537	1.0358	2.05	R
437	2.8756	3.9703	-1.0946	-2.17	R
438	2.8756	3.9703	-1.0946	-2.17	R
465	4.9058	5.9343	-1.0285	-2.05	R

471	4.3754	5.3995	-1.0241	-2.03	R
474	4.3754	5.3995	-1.0241	-2.03	R
478	3.7683	5.3995	-1.6312	-3.23	R

HIP' = transformed response
R Large residual

B10: Descriptive Statistics, HIP/minute by n/minute

Descriptive Statistics: HIP

Variable	n	Total Count	Mean	SE Mean	StDev	Variance	CoefVar	Minimum	Q1	Median
HIP	10	3	6.000	0.577	1.000	1.000	16.67	5.000	5.000	6.000
	11	54	5.019	0.282	2.069	4.283	41.24	2.000	3.000	5.000
	12	72	6.736	0.562	4.765	22.704	70.74	2.000	4.000	6.000
	13	30	16.87	1.14	6.25	39.09	37.07	4.00	11.75	17.50
	14	15	21.73	1.72	6.65	44.21	30.59	10.00	16.00	21.00
	15	9	28.56	2.76	8.29	68.78	29.04	14.00	22.50	30.00
	16	21	24.29	1.38	6.31	39.81	25.98	13.00	18.00	27.00
	17	24	27.33	1.49	7.30	53.36	26.73	13.00	25.00	27.50
	18	18	35.11	1.99	8.46	71.52	24.09	23.00	25.75	35.50
	19	12	31.00	3.25	11.26	126.73	36.31	15.00	24.25	30.00
	20	27	40.85	2.80	14.57	212.28	35.67	20.00	33.00	40.00
	21	36	43.86	1.55	9.32	86.92	21.26	24.00	37.00	45.50
	22	30	45.00	1.81	9.93	98.62	22.07	26.00	39.75	45.50
	23	6	45.33	4.77	11.67	136.27	25.75	29.00	36.50	44.00
	24	18	57.17	3.73	15.84	250.97	27.71	35.00	41.50	55.50
	25	6	68.67	7.85	19.22	369.47	27.99	41.00	51.50	71.00
	26	3	89.7	13.3	23.0	530.3	25.68	66.0	66.0	91.0
	28	18	64.11	4.41	18.71	350.22	29.19	30.00	45.75	66.50
	29	3	87.0	14.6	25.2	637.0	29.01	60.0	60.0	91.0
	30	6	80.33	7.51	18.40	338.67	22.91	56.00	59.00	85.00
	33	12	96.50	6.90	23.91	571.91	24.78	64.00	71.25	95.50

```
         34       9    94.67      5.43   16.29     265.50     17.21      72.00   80.50
96.00
         35      30    95.37      3.54   19.40     376.17     20.34      59.00   76.00
96.00
         36      18   105.22      5.88   24.93     621.36     23.69      59.00   86.50
103.00


Variable  n       Q3  Maximum    IQR  Skewness
HIP       10   7.000    7.000  2.000      0.00
          11   6.000   10.000  3.000      0.29
          12   8.000   26.000  4.000      2.44
          13   22.25    28.00  10.50     -0.03
          14   28.00    32.00  12.00      0.03
          15   36.00    39.00  13.50     -0.43
          16   29.00    33.00  11.00     -0.35
          17   31.75    38.00   6.75     -0.39
          18   41.00    52.00  15.25      0.12
          19   40.25    52.00  16.00      0.27
          20   48.00    73.00  15.00      0.48
          21   51.00    59.00  14.00     -0.26
          22   51.75    62.00  12.00     -0.24
          23   56.00    62.00  19.50      0.11
          24   68.50    88.00  27.00      0.43
          25   82.50    96.00  31.00     -0.09
          26   112.0    112.0   46.0     -0.26
          28   80.00   101.00  34.25      0.02
          29   110.0    110.0   50.0     -0.70
          30   96.50   101.00  37.50     -0.51
          33  114.25   139.00  43.00      0.20
          34  110.50   116.00  30.00      0.04
          35  109.25   131.00  33.25      0.02
          36  127.00   142.00  40.50     -0.25
```

B11: Max-min aircraft pairs vs. Variance