National Transportation Safety Board
Washington, DC 20594

Brief of Incident

Adopted 01/31/2006

LAX04IA302

File No. 19003 | 08/19/2004 | Los Angeles, CA | Aircraft Reg No. N461WN | Time (Local): 14:55 PDT

Make/Model:	Boeing / 737-7H4
Engine Make/Model:	General Electric / CFM-56
Aircraft Damage:	None
Number of Engines:	2
Operating Certificate(s):	Flag Carrier/Domestic
Name of Carrier:	SOUTHWEST AIRLINES CO
Type of Flight Operation:	Scheduled; Domestic; Passenger Only
Reg. Flight Conducted Under:	Part 121: Air Carrier

	Fatal	Serious	Minor/None
Crew	0	0	5
Pass	0	0	137

Last Depart. Point:	Los Angeles, CA
Destination:	Albuquerque, NM
Airport Proximity:	On Airport/Airstrip
Airport Name:	Los Angeles, CA
Runway Identification:	24L
Runway Length/Width (Ft):	10285 / 150
Runway Surface:	Concrete
Runway Surface Condition:	Dry

Condition of Light:	Day
Weather Info Src:	Weather Observation Facility
Basic Weather:	Visual Conditions
Lowest Ceiling:	None
Visibility:	10.00 SM
Wind Dir/Speed:	250 / 011 Kts
Temperature (°C):	22
Precip/Obscuration:	No Obscuration; No Precipitation

Pilot-in-Command Age: 41

Certificate(s)/Rating(s)
Airline Transport; Multi-engine Land

Instrument Rating
Airplane

Flight Time (Hours)

Total All Aircraft:	13000
Last 90 Days:	240
Total Make/Model:	9000
Total Instrument Time:	UnK/Nr

LAX04IA302

1.1 HISTORY OF FLIGHT

On August 19, 2004, about 1455 Pacific daylight time, an Asiana Airlines Boeing 747-400, HI7415, overflew a Southwest Airlines Boeing 737-7H4, N461WN, while the Southwest airplane was in position on the active runway 24L, at Los Angeles International Airport, Los Angeles, California. Southwest Airlines operated the Boeing 737 under the provisions of 14 CFR Part 121, and Asiana Airlines operated the Boeing 747 under the provisions of 14 CFR Part 129. There was no damage to either airplane nor injuries to the combined total of 417 passengers and 29 crewmembers. Visual meteorological conditions prevailed and an instrument flight plan had been filed.

On August 24th Southwest Airlines safety personnel reported to the National Transportation Safety Board investigator that the captain of Southwest flight 440

(SWA440) reported that an Asiana Boeing 747 (AAR204) came with in 200 feet of his airplane while it was executing a go-around on runway 24L. Southwest flight 440 had been cleared for takeoff on runway 24L. The captain stated that he became concerned when the Asiana airplane did not come in to his view, as it should have, when landing on the parallel runway 24R. He began to move his airplane off the runway when the Asiana airplane overflew his, coming within 200 feet. The captain of AAR204 stated that he and his copilot identified the runway conflict while they were on the short final approach for landing and executed a go-around about 400 feet above ground level (agl).

At 2151:21, the LAX local 2 (LC2) tower controller cleared AAR204 to land on runway 24L, and the flight crew acknowledged the landing clearance. AAR204 was conducting an ILS runway 24L approach and radar data indicated the aircraft was 9.3 miles east of the airport. About this time, the LAX operations supervisor on duty asked the local assist 1 (LA1) controller (hereafter referred to as the "LC2 relief controller") to relieve the LC2 controller, who needed a break.

At 2153:08, the LC2 controller began a position relief briefing for the LC2 relief controller. He stated, "Alright uh both runways available. Let's see you got the board you said. Got a lot of flow up there, a lot of flow. Better study up on that." The LC2 relief controller stated, "uh huh, I do I came from assist one." The LC2 controller continued, "Alright. They're on the boards, the inboards I should say, both runways available, PIREPs none, you can visual out. Uh, rolling out on the right is Southwest, cleared to land is Asiana on the left. Southwest on the pad is a LAXX I haven't tried to coordinate. You got a King Air, I'm sorry, he just left, so right now you're back to released. These two have been approved, but not run down or released…" The LC2 controller continued, "This one is awaiting approval," then stated, "and that's all I can think of." At 2153:43, the LC2 relief controller advised, "Alright well I've got it." The LC2 controller responded by saying, "Uh helicopters I'm sorry you have one more." The LC2 relief controller asked, "Oh and who is it?" As the LC2 controller began to say the helicopter's call sign, "Coast Guard six five...," he was interrupted by a transmission from a Southwest Airlines flight crew who had just landed runway 24R and requested permission to exit the runway at a different location than instructed. The LC2 controller approved the request, and after he received an acknowledgement from the Southwest crew, he continued briefing the LC2 relief controller.

At 2153:55, the LC2 controller completed the briefing by informing the LC2 relief controller of the Coast Guard helicopter's call sign and location on the airport, and that no other helicopters were operating in the vicinity of the airport. During the interview, the LC2 controller stated that at this time he unplugged his headset from the position and left to speak briefly with the supervisor about his break.

At 2154:06, the LC2 relief controller issued his first radio communication from the LC2 position, "Southwest four forty runway two four left position and hold." SWA440's flight crew acknowledged the instruction stating, "Position, and hold southwest four forty." At this time, AAR204 was 1.81 miles from the 24L runway threshold and the aircraft's altitude was 700 feet. According to the SWA440 Captain's statement, he turned onto taxiway V, which is perpendicular to runway 24L; he saw the Boeing 747 on final approach but believed the aircraft was landing on runway 24R.

The LC2 relief controller spent the next few seconds coordinating SWA440's southwesterly departure via the landline with the LAX local one (LC1) controller. At 2154:18, the LC2 relief controller stated, "Southwest four forty turn left heading two one zero runway two four left cleared for take off." The flight crew replied, "we'll turn two one zero cleared for takeoff runway two four left southwest four forty. AAR204 was 1.26 miles from the runway threshold and at 500 feet.

At 2154:26, the LC2 relief controller issued a wake turbulence advisory to the flight crew of UAL961, the lead aircraft on final approach to runway 24R and advised, "caution wake turbulence heavy seven forty seven short final." Radar data and recorded voice communications indicated UAL961 was not following any other aircraft to runway 24R. The wake turbulence advisory was in reference to AAR204 who was approximately 3 miles ahead of UAL961 but on final approach to runway 24L. The LC2 relief controller believed AAR204 was landing runway 24R, and therefore, a wake turbulence advisory would have been

required.

At 2154:40, an aural and visual alert was generated by the Airport Movement Area Safety System (AMASS) at the LC2 position. AAR204 was .4 miles from the runway at 300 feet. At this time, recorded voice communications indicated the LC2 relief controller was issuing a landing clearance to Sky West 6040, the second aircraft on final approach to runway 24R. According to the Asiana captain's statement, he observed the Southwest B737 approaching runway 24L but believed the aircraft would hold short of the runway. Once he recognized the aircraft was entering the runway, he initiated a go-around and estimated it was about the time he was passing through 400 feet.
At 2154:48, a voice of unknown origin stated on the frequency, "is that four seven going around?" AAR204 was .18 miles from the runway at 200 feet.

At 2154:50, the LC2 relief controller advised the flight crew of SWA440, "cancel take off clearance hold in position." The flight crew responded by saying, "holding in position southwest four forty." The controller then instructed the flight crew of AAR204, "fly heading two five zero climb and maintain two thousand." The flight crew replied, "heading two five zero climb and maintain two thousand asiana two zero going around now." Radar data indicated AAR204 had flown over SWA440, clearing the aircraft by about 200 feet, and was now .32 miles past the runway threshold and climbing out of 500 feet.

At 2155:07, the flight crew of SWA440 advised the LC2 relief controller, "we're going to go to echo eight and come back southwest four forty." The LC2 relief controller approved the request and instructed the flight crew to taxi and hold short of runway 24L at the full length. Echo eight is a designated taxi way off of runway 24L.

At 2156:23, the flight crew of SWA440 asked the LC2 relief controller, "what happened up there sir." The controller replied, "well he apparently was lined up for the wrong runway." The flight crew responded by saying, "ok yeah the runways are so close together we looked at it and it was so big we thought he was on the right side as well." In response, the LC2 relief controller said, "yep, I did the exact same thing."

Upon hearing the AMASS alert, the operations supervisor who was located on the south side of the tower cab began walking to the north side of the tower cab, and saw AAR204 in a nose-high attitude, 200 to 300 feet above the runway. The aircraft appeared to be executing a go-around. The supervisor continued to the LC2 position, and began monitoring the actions of the LC2 relief controller. The operations supervisor looked at the DBRITE display and saw information indicating that AAR204 was assigned to land on runway 24L. He asked the LC2 relief controller if he knew AAR204 was landing on runway 24L. The controller responded, "I did not know he was on the left." The LC2 controller, who was leaving the tower cab, also heard the AMASS alert. He also began walking toward the LC2 position, observed AAR204 climbing in a go-around attitude, and saw SWA440 turning onto the runway below AAR204. The operations supervisor asked the LC2 controller if he had told the LC2 relief controller AAR204 was landing on the left side. The LC2 controller advised that he had done so, and that SWA440 had been awaiting a takeoff clearance on the concrete pad adjacent to the approach end of the runway. The LC2 controller asked if he should relieve the LC2 relief controller. The supervisor advised him to do so.

1.5 PERSONNEL INFORMATION

1.5.1 The LC2 Tower-Controller

The LC2 controller held an air traffic control tower operator certificate and a current medical certificate. He entered on duty with the Federal Aviation Administration (FAA) on November 2, 1982. He was assigned to LAX in 2000, and received facility certification in 2002. Before his assignment to LAX, he previously worked at Kansas City Air Route Traffic Control Center (ARTCC), Los Angeles ARTCC, Los Angles TRACON, and Southern California TRACON (SCT). On the day of the incursion, he had been working the LC2 position for about 1 1/2 hours before the relief LC2 controller relieved him.

1.5.2 The LC2 Relief Tower-Controller

The FAA hired the LC2 relief controller as an air traffic controller in 1987. After completing his initial training at the FAA academy, the relief LC2 controller was assigned to Fullerton Tower (FUL) until 1990. In 1990, he was assigned to Orange County Tower (SNA) and remained there until he was assigned to LAX in 2000, where he received facility certification in 2001.

The LC2 relief controller had no history of operational errors or disciplinary action in the FAA. His supervisor described him as "the best controller on his crew," adding that he was a "conscientious controller" who "gave 100 percent." The LC2 relief controller's coworkers also spoke favorably about his performance. The LC2 controller said he had "a lot of confidence" in the LC2 relief controller. He said if someone else had relieved him, he might have remained at the LC2 position longer after the position relief briefing was completed.

The LC2 relief controller's most recent second-class medical certificate, dated May 28, 2004, included a limitation stating "must have glasses for near vision in his/her immediate possession while performing ATC duties." He reported having glasses with him at the time of the incursion, but stated that he was not wearing them and did not need them for the tasks he was performing. He stated that he did not take prescription medications, and said he took no medications of any kind in the 72 hours before the incursion. He said he did not smoke and reported only occasional light use of alcohol. He reported no significant recent changes in his finances or personal life.

The LC2 relief controller's residence was a 45-minute drive from LAX. Mondays and Tuesdays were his regular days off. He rarely slept or took naps during the day. On his days off, he said he usually went to bed about 2200 and woke up between 0800 and 0900. He said he treated his weekends as recovery time, attempting to get at least 9 hours of sleep per night. The LC2 relief controller's normal weekly work schedule included afternoon shifts on Wednesday and Thursday, early morning shifts on Friday and Saturday, and either a midnight or early morning shift on Sunday.

The LC2 relief controller had modified his schedule for the day of the incursion, working a shift that began in the early morning rather than in the afternoon. He did this for personal reasons. This change afforded him a rest period of 8 hours on Wednesday night. The controller referred to this rest period as a "quick turnaround." A review of tower watch schedules indicated that the 8-hour rest period the LC2 relief controller received the night before the incursion was his shortest in the previous 30 days. His next shortest rest periods were 9 hours long.

The LC2 Relief Controller's 72-Hour History

On Monday, August 16, 2004, the relief controller had a scheduled day off. He engaged in routine activities and went to sleep about 2200.

On Tuesday, August 17th, the relief controller had another scheduled day off. He woke about 0800, engaged in routine activities, and went to sleep about 2200.

On Wednesday, August 18th, the relief controller woke about 0800, and engaged in routine activities at his home. He said he felt fully rested when he began his shift at 1530. He finished his shift at 2330, drove home, and slept for "five or six hours."

On Thursday, August 19th, the relief controller woke about 0600, got ready for work, drove to the tower, and began his shift at 0730. He described his shift leading up to the incursion as a "hard day." He felt tired because he had not received enough sleep the night before and worked several busy positions during the shift.

Tower position logs for August 19, 2004, showed the relief controller spent 5 hours 36 minutes on position, out of a total of 7 hours 25 minutes on duty before the incursion.

1.9 COMMUNICATIONS

The Los Angeles Air Traffic Control Tower is a Level 12 ATC facility. The tower is centrally located on the airport between the north and south complexes. The tower can accommodate up to 13 positions; 2 local control (LC1/LC2), 2 local assist (LA1/LA2), 3 ground control (GC1/GC2/GC3), 2 clearance delivery (CD1/CD2), 1 helicopter position (HC), 1 traffic management coordinator (TM), and 2 supervisors (AS1/AS2).

On the day of the incursion, LAX was in a west configuration, the north complex was landing and departing runway 24R/24L, and the south complex was landing and departing runway 25R/25L.

1.9.1 Equipment

The LAX tower is equipped with 7 DBRITE (Digital Bright Radar Indicator Terminal Equipment) systems, which are located at the LC1/2, GC1/2/3, helicopter, and traffic management positions. The system displays primary and secondary radar returns of aircraft and alphanumeric target symbols generated by the LAX ARTS IIIE system. The data is derived from the Los Angeles ASR-9 radar located on the airport. The DBRITE displays aircraft target symbols each with a corresponding (Automated Terminal Radar System) ARTS data block. The data block provides aircraft information to the controller. Line 1 of the data block indicates the aircraft call sign. Line 2 contains current altitude (in hundreds of feet) and ground speed (in tens of knots). These two items of line 2 data are time shared with two other items, which are referred to as "scratch pad" information. At LAX the scratch pad items are: current runway assignment or type approach (e.g., ILS runway 24L approach is displayed as "I4L") and aircraft type (e.g. Boeing 747-400 is displayed as "B744"). Information displayed in the scratch pad area alternates between altitude/ground speed and assigned runway/aircraft type. A review of the radar playback of the LC2 DBRITE display indicated that at the time of the incursion AAR204's altitude and ground speed were displayed for 15 second intervals, alternating with displays of assigned runway and aircraft type, which lasted 5 seconds.

The LAX tower's AMASS is a computer software enhancement to the airport surface detection equipment. The system provides logic predicting the path of aircraft landing and/or departing, and aircraft and/or vehicle movements on runways. Visual and auditory alerts are activated when logic projects a potential collision. AMASS alerts controllers to a potential collision when an aircraft or vehicle is occupying a runway and when arriving or departing aircraft cross a certain threshold or attain a certain speed. The system works by processing surveillance data from ground radar, and then predicting possible conflicts based on the position, velocity, and acceleration of arriving and departing aircraft and vehicles.

Both the DBRITE and AMASS systems augment visual observations by tower personnel of arriving and departing aircraft.

During the field investigation, the ATC group toured the tower cab and from the LC2 position, the local controller appears to have a good view of traffic approaching the airport from the east. However, tower personnel reported that it could be difficult to visually determine whether an aircraft is approaching runway 24L or runway 24R because of the location of the tower relative to the runway thresholds. This was reported to be most difficult with large aircraft.

1.10 AERODROME INFORMATION

The Los Angeles International Airport is located in the northwest suburbs of Los Angeles, adjacent to the Pacific coastline. The terrain is largely flat to coastal with large expanses of urban areas.

The airport has dual parallel runways. Runways 6L/24R and 6R/24L are referred to as the north complex and runways 7L/25R and 7R/25L comprise the south complex. Runway 24L is 10,285 feet long and 150 feet wide with no displaced threshold. True runway heading is 263 degrees.

The airport lies within Class D airspace whose dimensions extend 5 miles from the airport and from the surface, up to but not including 2,500 feet agl. Los Angeles Class B airspace overlays the LAX Class D airspace.

The Southern California Terminal Radar Approach Control (SCT) provides approach control services to LAX.

1.11 FLIGHT RECORDERS

Southwest Airlines downloaded the FDR from the Boeing 737 and sent the raw binary data file to the National Transportation Safety Board's Vehicle Recorder Laboratory. The FDR data from AAR204 was overwritten before it could be downloaded.

The Flight Data Recorder Specialist's Factual Report is located in the official docket of this investigation.

1.17 ORGANIZATIONAL AND MANAGEMENT INFORMATION

1.17.1 Tower Staffing

At the time of the incursion, five certified professional controllers and one operations supervisor were working in the tower cab. Both local (LC1/LC2) and ground control (GC1/GC2) positions and the clearance delivery position were open. An operations supervisor was on duty and assigned to oversee the operation. The local assist positions were not opened. The LC1 and LC2 controllers were both working the local assist functions in conjunction with their local control duties. In addition, the LC2 controller was also responsible for the helicopter position. One controller assigned to work as the traffic management coordinator was on a break. According to facility personnel, there would normally be 10 people assigned to the shift. However, 3 controllers who were assigned to the shift were absent, due to injuries, 2 were on sick leave, and the other worked an earlier shift to accommodate a doctor's appointment.

The operations supervisor stated during the interview that he was a little short on personnel at the time of the incursion, and had been carefully monitoring controller assignments to ensure that key positions were continuously manned and that no controller exceeded a maximum of 2 hours continuous time on position.

The basic watch schedule is defined as the days of the week, hours of the day, rotation of shifts, and change in regular days off. Procedures for employees bidding and assignment to the basic watch schedule are negotiated in accordance with the collective bargaining agreement and the FAA at the local facility level. FAA Order 7210.3, "Facility Operation and Administration," paragraph 2-6-7, Basic Watch Schedule, states in part that facility watch schedules shall take into account normal traffic flow, thereby permitting the posting of a continuing schedule for an indefinite period. Facility management is responsible for ensuring watch schedules are in accordance with collective bargaining agreements. Air traffic control specialists whose primary duties are those directly related to the control and separation of aircraft must meet the following criteria: (1) do not work more than 10 operational hours in a shift; (2) have at least an 8-hour break from the time work ends to the start of any subsequent shift and; (3) do not work more than six shifts without taking a regular day off.

1.17.2 Tower Training and Procedures

1.17.2.1 Air Traffic Control Guidelines

FAA Order 7110.65, "Air Traffic Control", paragraph 3-10-3, Same Runway Separation states in part:

a. Separate an arriving aircraft from another aircraft using the same runway by ensuring that the arriving aircraft does not cross the landing threshold until one of the following conditions exists or unless authorized in paragraph 3-10-10, Altitude Restricted Low Approach.

2. The other aircraft has departed and crossed the runway end. If you can determine distances by reference to suitable landmarks and the other aircraft is airborne, it need not have crossed the runway end if the following minimum distance from the landing threshold exists:

(a) Category I aircraft landing behind Category I or II- 3,000 feet.
(b) Category II aircraft landing behind Category I or II- 4,500 feet.
(c) When either is a category III aircraft- 6,000 feet. (See FIG 3-10-5.)

1.17.2.2 Training

All controllers at LAX completed a computer-based training module on "listening and remembering" during the month of August 2004, before the runway incursion. The training module, which was developed by the FAA and was customized for LAX, addressed specific visual and auditory cues that could be used to enhance controller memory.

Position Relief Briefing

FAA Order 7110.65, Appendix D, "Standard Operating Practice for the Transfer of Position Responsibility" outlines the method for conducting a position relief briefing and the FAA provided the Safety Board with a "Local Control / Local Assist Briefing Checklist" used to guide position relief briefings at LAX.

FAA Order 7110.65, Appendix D, Standard Operating Practice (SOP) for the Transfer of Position Responsibility states in part:

1. PURPOSE

This appendix prescribes the method and systematic process for conducting a position relief briefing and transferring position responsibility from one specialist to another.

2. DISCUSSION

a. In all operational facilities, the increase in traffic density and the need for the expeditious movement of traffic without compromising safety have emphasized the importance of the position relief process.

b. The contents, methods, and practices used for position relief and briefings vary among personnel, and pertinent information is often forgotten or incompletely covered. Major problems occur whenever there is a heavy reliance upon memory, unsupported by routines or systematic reminders. This SOP addresses the complete task of transferring position responsibility and the associated relief briefing.

c. Position relief unavoidably provides workload for specialists at the time of relief. The intent of this SOP is to make the transfer of position responsibility take place smoothly and to ensure a complete transfer of information with a minimum amount of workload. The method takes advantage of a self-briefing concept in which the relieving specialist obtains needed status information by reading from the Status Information Area/s to begin the relief process. Current information related to the control of aircraft or vehicular movements requires verbal exchanges between specialists during the relief process. The method also specifies the moment when the transfer of position responsibility occurs.

d. In the final part of the relief process, the specialist being relieved monitors and reviews the position to ensure that nothing has been overlooked or incorrectly displayed and that the transfer of position responsibility occurred with a complete briefing.

3. TERMS

The following terms are important for a complete understanding of this SOP:

a. Status Information Area (SIA). Manual or automatic displays of the current status of position related equipment and operational conditions or procedures.

b. Written Notes. Manually recorded items of information kept at designated locations on the position of operation. They may be an element of the Status Information Area/s.

c. Checklist. An ordered listing of items to be covered during a position relief.

4. PRECAUTIONS

a. Specialists involved in the position relief process should not rush or be influenced to rush.

b. During position operation, each item of status information, which is or may be an operational factor for the relieving specialist, should be recorded as soon as it is operationally feasible so that it will not be forgotten or incorrectly recorded.

c. Extra care should be taken when more than one specialist relieves or is being relieved from a position at the same time; e.g., combining or decombining positions. Such simultaneous reliefs should be approached with caution.

5. RESPONSIBILITIES

a. The specialist being relieved shall be responsible for ensuring that any pertinent status information of which he/she is aware is relayed to the relieving specialist and is either:

1. Accurately displayed in the Status Information Area/s for which he/she has responsibility, or

2. Relayed to the position having responsibility for accurately displaying the status information.

b. The relieving specialist shall be responsible for ensuring that, before accepting responsibility for the position, any unresolved questions pertaining to the operation of the position are resolved.

c. The relieving specialist and the specialist being relieved shall share equal responsibility for the completeness and accuracy of the position relief briefing.

d. The specialists engaged in a position relief shall conduct the relief process at the position being relieved unless other procedures have been established and authorized by the facility air traffic manager.

NOTE-
The ``sharing'' of this responsibility means that the specialist being relieved is obligated to provide a complete, accurate briefing and the relieving specialist is obligated to ensure that a briefing takes place and is to his/her total satisfaction.

The transfer of position responsibility is accomplished in accordance with appropriate FAA and facility directives each time operational responsibility for a position is transferred from one controller to another. To the maximum extent practicable, the position relief briefing is recorded. Generally, the position relief briefing begins with a self-briefing phase. The relieving controller obtains needed status information by reading from the Status Information Area/s to begin the relief process. Next, information related to the control of aircraft or vehicular movements is verbally exchanged between controllers. In the final part of the relief process, the controller being relieved monitors and reviews the position to ensure that nothing has been overlooked or incorrectly displayed and that the transfer of position responsibility occurred with a complete briefing. The extent of content, method, and practices used for position relief briefings vary depending upon the operational circumstances at the time of the briefing.

1.17.3 Tower Notification of Event

On August 24, 2004, the Safety Board became aware of this event by a telephone report from Southwest Airlines, which was 5 days after it had occurred. LAX management personnel did not report the event to the FAA's Regional Operations Center because they believed it did not fall within the parameters that required notification. Immediately following the event, LAX management personnel conducted an investigation and determined notification was not necessary because the flight crew of AAR204 initiated a go-around before reaching the runway 24L landing threshold. Instead, the incident was logged in the facility's daily record of operation, dated August 10, 2004, and annotated as a QAR (quality assurance report). Once the Safety Board began to investigate, LAX management personnel conducted a further review of the events, and in discussions with FAA Headquarters' quality assurance personnel, reclassified the event from a QAR to an operational error on September 15, 2004.

1.18 ADDITIONAL INFORMATION

1.18.1 Human Performance

The Safety Board examined factors that could have affected the relief controller's performance. These factors included memory limitations, visual factors, display characteristics, and fatigue.

1.18.1.1 Memory Limitations

Human memory is critical to the performance of tactical air traffic control tasks. The human memory system is subdivided into two major components, long term memory and working memory. Long term memory has no known capacity, is fairly permanent, and supports information retrieval with little conscious effort. Working memory is capacity limited, and requires conscious attention for the maintenance and retrieval of information. On average, people can maintain a maximum of seven plus or minus two units of information in short term memory. Without conscious attention, however, this information is forgotten in about 15 seconds.

Verbal information like that conveyed during a position relief briefing is first stored in working memory in terms of phonetic codes. The information remains in this form until it is converted into meaningful semantic codes through a process known as elaborative rehearsal. Through elaborative rehearsal, information held in working memory is related to information contained in long-term memory, activating information in long term memory, which can be used to guide task performance. This is necessary for the creation of a meaningful mental "picture" of the traffic situation. Moreover, research has shown that the information that is rehearsed more is remembered longer.

Research with air traffic controllers has shown that controllers are better than novices at processing information about multiple aircraft, and that the maximum number of items of traffic information that can be remembered increases with controller experience. Experienced controllers also appear to be good at efficiently prioritizing and focusing on key information so that critical attributes are better remembered. However, even experienced controllers experience memory errors. In a 1992 study sponsored by the FAA, 92 percent of air traffic controllers reported having experienced a "memory lapse" on the job, and 55 percent reported experiencing a memory lapse resulting in a system error.

Studies have shown that controller recall accuracy decreases as the number of aircraft increases. Accuracy also declines quite rapidly if additional cognitive activities are required between the time information is presented and the time it is recalled. Limitations such as these have long been identified as a weakness for human information processing, and as a reason for some kinds of controller errors.

1.18.1.2 Position Relief Brief

During a position relief briefing, it is the responsibility of the relieving controller to ensure all information specific to the operation and position is accurately relayed to the relief controller. The relief controller is responsible for ensuring that, before accepting responsibility for the position, he/she has a full understanding of the operation.

Controllers are required to use a checklist when conducting position relief briefings. FAA Order 7210.3, "Facility Operation and Administration," paragraph 2-2-4, specifies items to be addressed in the checklist, which include, but are not limited to, equipment and operational conditions that are likely to be a factor at a specific position. A review of the LAX position relief-briefing checklist for the LC2 position revealed that it was designed in accordance with FAA directives.

Currently, there is no requirement for a relieving controller to remain at the position once transfer of position responsibility has been completed. In 1996, the FAA implemented a policy mandating a 5-minute overlap period when transferring position responsibility from one specialist to another. The policy required the relieving controller to remain at the position for 5 minutes after transferring position responsibility to the relief controller. The intent of the policy was to ensure continuity during transfer of control responsibility and ensure nothing had been overlooked or incorrectly explained during the briefing. The policy lasted a few months and was replaced with a systemic method of conducting briefings, which is highlighted in FAA Order 7110.65, Appendix D.

1.18.1.3 Visual Information

The relief controller stated that he saw AAR204's radar target on the DBRITE display during the position relief briefing, but that he did not specifically recall seeing AAR204's data block. A review of the radar replay indicated AAR204's data block displayed two sets of aircraft information: runway assignment and aircraft type were presented for 5 seconds; followed by a 15-second presentation of altitude and ground speed data.

Visual sampling is performed by a combination of rapid saccadic eye movements and fixations. Although visual fixations can vary in duration, fixation durations for skilled readers have been measured at between 200 and 250 milliseconds. If the controller had gazed at AAR204 on the DBRITE for 1 second, he would have had only a 25 percent probability of seeing AAR204's alphanumeric runway assignment. The probability of seeing the runway assignment would have increased if a longer fixation or additional short fixations were made. It is impossible to know how many times, or for how long, the relief controller gazed at the DBRITE display

1.18.1.4 Fatigue

Research on sleep and human performance points to an optimal sleep length of between 8 and 9 hours per night for most people. Studies conducted under controlled laboratory conditions have found that restricting sleep to 4-6 hours for one night causes moderate increases in subjective sleepiness and slight decreases in cognitive performance on tasks involving working memory and reaction time.

The complete ATC and Human Factors Specialist's Factual Report is contained in the official docket of this investigation.

The National Transportation Safety Board determines the probable cause(s) of this incident as follows.
a loss of separation between Southwest flight 440 and Asiana flight 204 due to the LC2 relief controller's failure to appropriately monitor the operation and recognize a developing traffic conflict. Contributing factors included the FAA's position relief briefing procedures, the formatting of the DBRITE radar displays in the LAX tower, controller fatigue, and the tower supervisor's staffing decisions on the day of the incident.