

Descent Below Visual Glidepath and Impact With Seawall  
Asiana Airlines Flight 214  
Boeing 777-200ER, HL7742  
San Francisco, California  
July 6, 2013



**Accident Report**

NTSB/AAR-14/01  
PB2014-105984



**National  
Transportation  
Safety Board**

## Abbreviations

<b>AC</b>	advisory circular
<b>ACARS</b>	aircraft communications addressing and reporting system
<b>ACRP</b>	Airport Cooperative Research Program
<b>AD</b>	airworthiness directive
<b>AFCS</b>	automatic flight control system
<b>AFDS</b>	autopilot flight director system
<b>AFE</b>	above field elevation
<b>AFFF</b>	aqueous film forming foam
<b>AFM</b>	airplane flight manual
<b>agl</b>	above ground level
<b>A/P</b>	autopilot
<b>ARAC</b>	Aviation Rulemaking Advisory Committee
<b>ARFF</b>	aircraft rescue and firefighting
<b>ASHWG</b>	Avionics Systems Harmonization Working Group
<b>ASO</b>	airfield security officer
<b>A/T</b>	autothrottle
<b>ATC</b>	air traffic control
<b>ATCT</b>	air traffic control tower
<b>ATIS</b>	automatic terminal information service
<b>BS</b>	body station
<b>CFR</b>	<i>Code of Federal Regulations</i>
<b>CG</b>	center of gravity
<b>CRM</b>	crew resource management

<b>CVR</b>	cockpit voice recorder
<b>DFW FTTC</b>	Dallas/Fort Worth International Airport Fire Training Research Center
<b>EASA</b>	European Aviation Safety Agency
<b>EFS</b>	engineering flight simulator
<b>EGPWS</b>	enhanced ground proximity warning system
<b>EICAS</b>	engine indication and crew alerting system
<b>EMS</b>	emergency medical service
<b>FAA</b>	Federal Aviation Administration
<b>FAF</b>	final approach fix
<b>FCOM</b>	flight crew operating manual
<b>FCTM</b>	flight crew training manual
<b>F/D</b>	flight director
<b>FDR</b>	flight data recorder
<b>FLCH SPD</b>	flight level change speed
<b>FMA</b>	flight mode annunciator
<b>FMC</b>	flight management computer
<b>FO</b>	first officer
<b>FOM</b>	flight operations manual
<b>fpm</b>	ft per minute
<b>FRMS</b>	fatigue risk management system
<b><i>g</i></b>	ratio of a particular acceleration to the acceleration due to gravity at sea level
<b>HDG SEL</b>	heading select
<b>HRET</b>	high-reach extendable turret
<b>ICAO</b>	International Civil Aviation Organization

NTSB

Aircraft Accident Report

ICN

Incheon International Airport

IFR

instrument flight rules

ILS

instrument landing system

IMC

instrument meteorological conditions

IP

instructor pilot

KARAIB

The Republic of Korea Aviation and Railway Accident Investigation Board

KOCA

The Republic of Korea Office of Civil Aviation

L

left

LOC

localizer

MCP

mode control panel

MSAW

minimum safe altitude warning

msl

mean sea level

ND

navigation display

nm

nautical mile

NorCal

Northern California Terminal Radar Approach Control

NOTAM

notice to airmen

NTSB

National Transportation Safety Board

OE

operating experience

PAPI

precision approach path indicator

PF

pilot flying

PFD

primary flight display

PIC

pilot-in-command

PM

pilot monitoring

POI

principal operations inspector

NTSB

Aircraft Accident Report

**POM**

pilot operations manual

**QAR**

quick access recorder

**QRH**

quick reference handbook

**R**

right

**RA**

radio altitude

**RI**

response item

**RSA**

runway safety area

**SAFO**

safety alert for operators

**SFFD**

San Francisco Fire Department

**SFFD-AB**

San Francisco Fire Department-Airport Bureau

**SFO**

San Francisco International Airport

**SFPD**

San Francisco Police Department

**SOP**

standard operating procedure

**SPD**

speed

**START**

simple triage and rapid treatment

**THR**

thrust

**TO/GA**

takeoff/go-around

**V<sub>ref</sub>**

reference landing speed

**VMC**

visual meteorological conditions

**VNAV**

vertical navigation

**VPI**

vertical path indicator

**V/S**

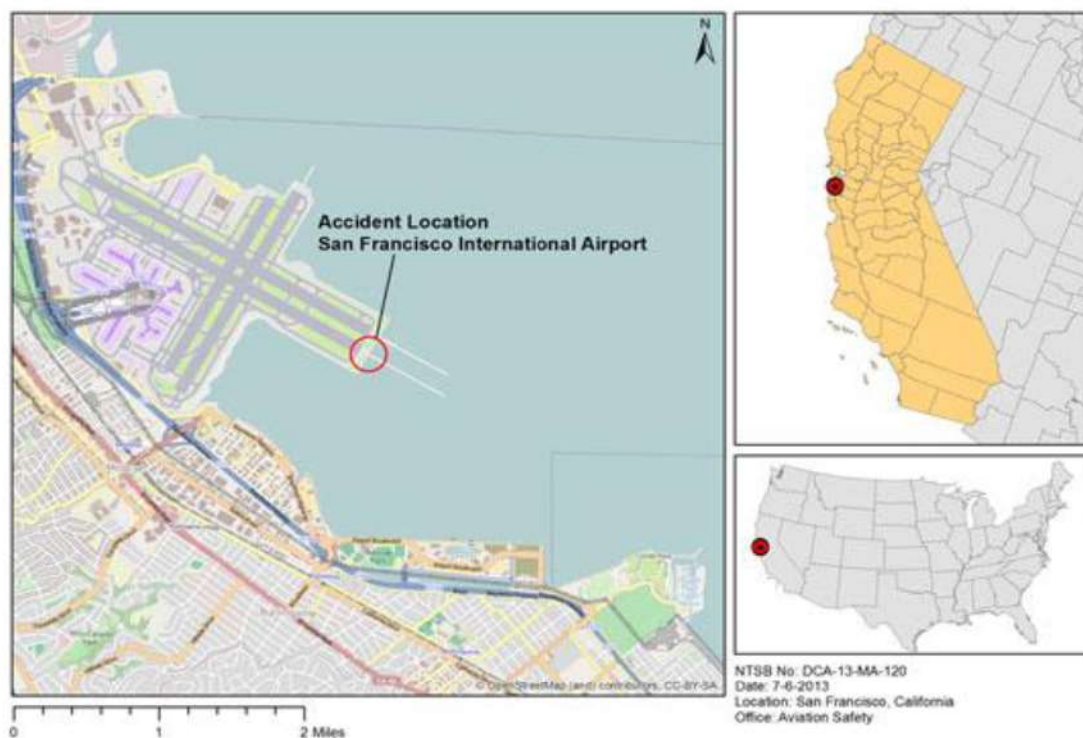
vertical speed



# 1. Factual Information

## 1.1 History of Flight

On July 6, 2013, about 1128 Pacific daylight time,<sup>1</sup> a Boeing 777-200ER, Korean registration HL7742, operating as Asiana Airlines flight 214, was on approach to runway 28L when it struck a seawall at San Francisco International Airport (SFO), San Francisco, California. Three of the 291 passengers were fatally injured; 40 passengers, 8 of the 12 flight attendants, and 1 of the 4 flight crewmembers received serious injuries. The other 248 passengers, 4 flight attendants, and 3 flight crewmembers received minor injuries or were not injured. The airplane was destroyed by impact forces and a postcrash fire. Flight 214 was a regularly scheduled international passenger flight from Incheon International Airport (ICN), Seoul, Korea, operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 129. Visual meteorological conditions (VMC) prevailed, and an instrument flight rules (IFR) flight plan was filed. Figure 1 is a map showing the location of the accident.

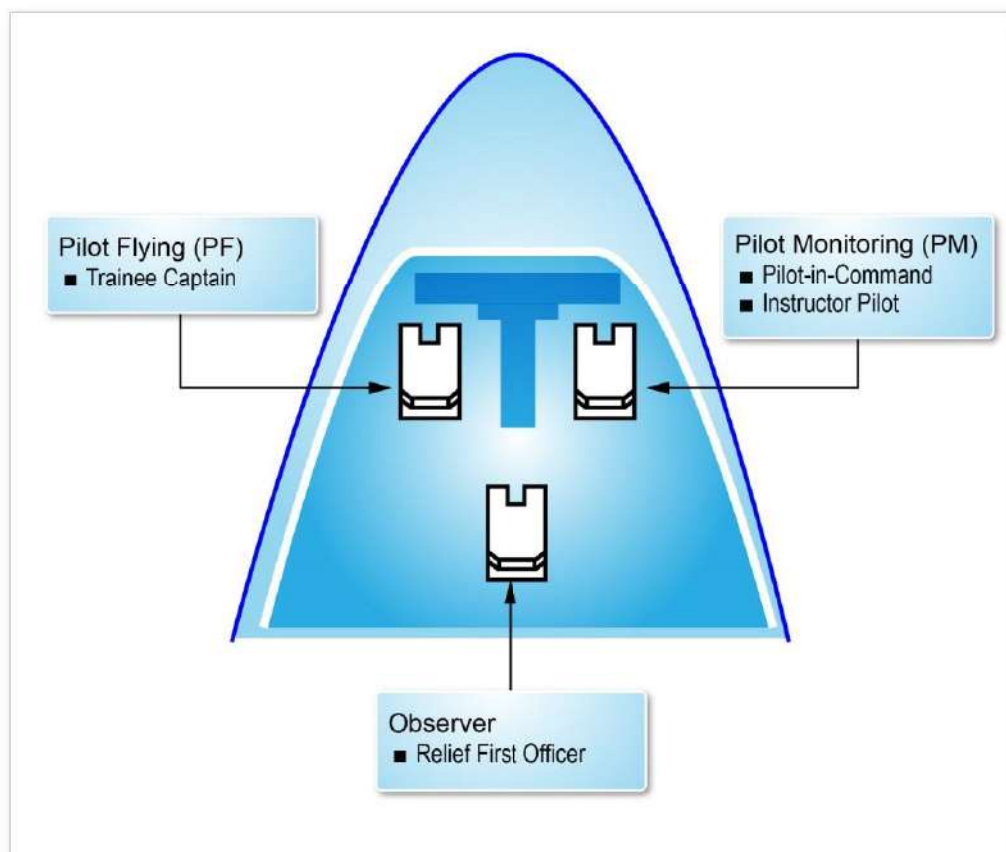


**Figure 1.** Map of the accident location.

<sup>1</sup> All times in this report are Pacific daylight time (unless otherwise noted) and based on a 24-hour clock.

The flight and cabin crews were based at ICN. Two of the flight crewmembers, a trainee captain and an instructor pilot (IP), were the primary flight crew, and the other two flight crewmembers, a second captain and a first officer (FO), were relief pilots. The flight, which was the first of a scheduled 2-day trip with a scheduled layover in San Francisco, was an operating experience (OE) training flight for the trainee captain. The flight plan showed an estimated time en route of 10 hours 24 minutes.

As shown in figure 2, the trainee captain occupied the left seat and was the pilot flying (PF) for the takeoff and landing. The IP, who was the pilot-in-command (PIC), occupied the right seat and was the pilot monitoring (PM) for the takeoff and landing. The relief captain and FO occupied seats in the cabin for takeoff and during the initial part of the flight. About 4 hours 15 minutes after takeoff, they came forward to the cockpit and assumed flight crew duties for about the next 5 hours 15 minutes of the flight, allowing the primary flight crew to rest in the cabin.



**Figure 2.** Diagram of cockpit showing flight crew roles.



The PF stated in an interview that he returned to the cockpit about 0938. According to the relief captain, he told the PF that he had programmed the flight management computer (FMC) with the instrument landing system (ILS)/localizer (LOC) 28L approach and advised him of the likelihood that the flight would be held at high altitude and/or high speed by air traffic control (ATC) for longer than normal during the approach to SFO. The relief captain stated that the PM returned to the cockpit about 10 minutes after the PF's return.

According to the cockpit voice recorder (CVR), at 0955:45, there was a transfer of aircraft control to the PF and the PM, and the relief captain and FO returned to the cabin. About 6 minutes later, the PF and the PM discussed expectations for receiving radar vectors for a visual approach.<sup>2</sup> At 1042:28, the PF began an approach briefing. During his briefing, the PF referred to automatic terminal information service (ATIS) Juliet,<sup>3</sup> which included the information that visual approaches to runways 28L and 28R were in progress, and the ILS glideslopes<sup>4</sup> for these runways were out of service. The PF stated that he expected vectors for a visual approach to runway 28L, would use the LOC to maintain lateral path, and, after capturing the LOC, would use the automatic flight control system (AFCS)<sup>5</sup> to manage the vertical profile. He said that the minimum descent altitude for the LOC approach was 460 ft mean sea level (msl) and that he would set a go-around altitude of 3,000 ft msl in case of a missed approach. Figure 3 is the instrument approach chart for the SFO runway 28L ILS or LOC Z procedure.

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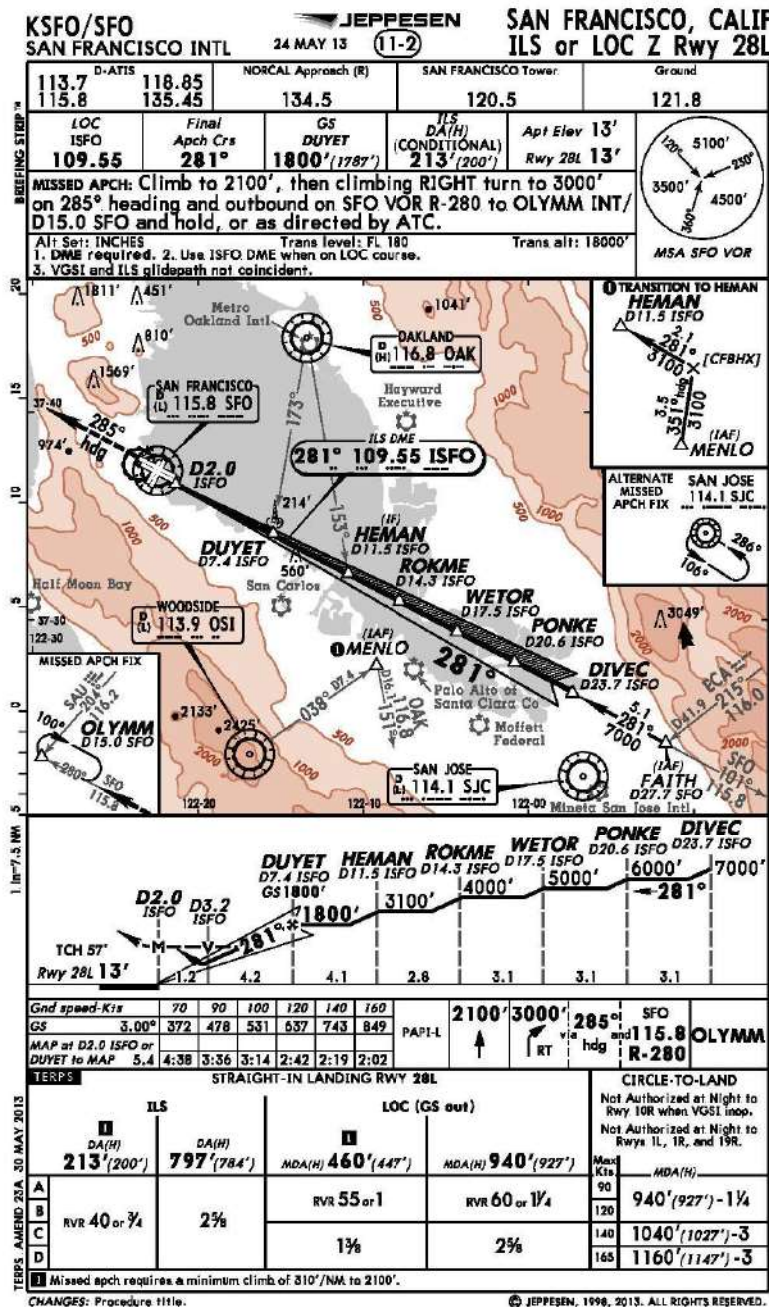
<sup>2</sup> The Federal Aviation Administration defines a visual approach as an ATC authorization for an aircraft on an IFR flight plan to proceed visually to the airport of intended landing. It is not an instrument approach procedure, and there is no missed approach segment.

<sup>3</sup> Juliet was the assigned code for the ATIS broadcast given at 0956. The ATIS changed to information Kilo at 1056, but the content of the broadcast was not significantly different.

<sup>4</sup> The terms glideslope and glidepath are commonly used interchangeably. For the purposes of this report, glideslope refers to the electronic radio aid portion of the ILS that provides vertical guidance, and glidepath refers to a descent profile determined for vertical guidance during a final approach. When specific glidepaths are referenced, the method of determining the glidepath will be stated (for example, "PAPI [precision approach path indicator] glidepath").

<sup>5</sup> Specifically, the PF stated that he would use the vertical speed pitch mode of the autopilot flight director system (AFDS). Along with the autothrottle, the AFDS is a subsystem of the 777 AFCS. See section 1.6.3 for additional information about the functionality of these systems.





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**Figure 3.** Instrument approach chart for the SFO runway 28L ILS or LOC Z procedure.

At 1047:28, the PF called for the descent checklist. The PM acknowledged the callout and began to run the checklist, which included verification that the reference landing speed ( $V_{ref}$ )<sup>6</sup> was 132 knots. At 1047:54, the PM stated, "checklist completed." At 1112:33, the relief

<sup>6</sup>  $V_{ref}$  is 1.23 times the airplane's stalling speed in the landing configuration. It is the speed required on crossing the landing runway threshold at a 50-ft height to achieve calculated aircraft performance.



FO returned to the cockpit, occupied the center jumpseat, and acted as an observer during the approach and landing.<sup>7</sup> As the flight proceeded towards SFO, it was cleared to descend to lower altitudes and vectored to intercept a straight-in approach to runway 28L.

At 1121:49, a controller at Northern California Terminal Radar Approach Control (NorCal) asked if the flight crew had the airport in sight. The PM replied, "okay runway in sight," and the controller cleared the flight for a visual approach to runway 28L. According to flight data recorder (FDR) data, when the approach clearance was given, the airplane was descending through about 6,300 ft msl. The airplane's airspeed was about 211 knots; it was configured with the flaps and landing gear up; the autothrottle (A/T) was in hold (HOLD) mode; and the autopilot flight director system (AFDS) was in flight level change speed (FLCH SPD) pitch mode and heading select (HDG SEL) roll mode.<sup>8</sup>

At 1122:07, the PF stated, "I am intercepting localizer," and the PM responded, "yes." At 1122:11, the LOC<sup>9</sup> push-button switch on the AFCS's mode control panel (MCP) was pushed, arming the LOC mode, and the PM stated, "localizer armed," to which the PF replied, "check, cleared visual approach." At 1122:46, the PF stated, "next, three thousand one hundred" and then "cleared visual approach," and the PM replied "check." At 1122:48, the MCP-selected altitude changed to 3,100 ft. At 1122:52, LOC capture occurred, and the AFDS roll mode changed from HDG SEL to LOC, where it remained for the duration of the flight. At this time, the airplane was about 15.4 nautical miles (nm) from the runway threshold, descending through about 5,300 ft msl at an airspeed of about 210 knots.

At 1122:54, the PM stated, "let's descend slowly to one thousand eight hundred feet, and it's visual." The PF replied, "yes yes sir I will set to one thousand eight hundred." At 1123:02, the MCP-selected altitude was changed to 1,800 ft, which was the minimum altitude for the DUYET waypoint, located 5.4 nm from the runway and the final approach fix (FAF) for the ILS/LOC 28L approach.<sup>10</sup> At 1123:05, the PM stated, "localizer capture." The PF replied, "check, flaps one sir," and the PM stated, "speed check flaps one set." At 1123:11, the flap lever was moved to the flaps 1 position as the airplane was descending through about 4,900 ft msl at an airspeed of about 214 knots. At 1123:16, the PF stated, "speed one nine two set," and the MCP-selected airspeed changed from 212 to 192 knots.

At 1123:17, when the airplane was about 14.1 nm from the runway, descending through about 4,800 ft msl at an airspeed of about 215 knots and a descent rate of about 900 ft per minute (fpm), the NorCal controller instructed the flight to reduce airspeed to 180 knots and to maintain that speed until 5 miles from the airport; the PM acknowledged the instruction. At 1123:31, the PF stated, "speed one eight zero," and the PM replied, "check." At 1123:33, the PF stated, "flaps

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<sup>7</sup> The relief captain remained in the cabin for the descent, approach, and landing.

<sup>8</sup> In HOLD mode, the A/T will not move the thrust levers; FLCH SPD pitch mode moves the elevator to maintain the selected airspeed; and HDG SEL roll mode maintains the selected heading. See section 1.6.3 for further description of the airplane's AFCS.

<sup>9</sup> The LOC roll mode captures and tracks the localizer centerline.

<sup>10</sup> Because flight 214 was conducting a visual approach, there was no requirement for the flight to cross DUYET at 1,800 ft. The flight crew chose to use this altitude as a reference.



five.” About 3 seconds later, the PM made an unintelligible comment, and the MCP-selected airspeed changed to 180 knots. At 1123:42, the PF stated, “flaps five sir,” and the PM replied, “speed check” and then “flaps five.” At 1123:45, the flap lever was moved to the flaps 5 position.

By 1123:50, the airplane’s descent rate had decreased to about 300 fpm, and the PM made an unintelligible comment. About 2 seconds later, the MCP-selected airspeed changed to 172 knots. At 1123:53, the PF stated, “yeah, I am descending now,” and the PM replied, “yeah.” At 1123:57, the AFDS pitch mode changed to vertical speed (V/S);<sup>11</sup> the A/T mode changed to speed (SPD) mode;<sup>12</sup> and the MCP-selected vertical speed was set to -900 fpm. At 1123:58, the PM called out the pitch mode change by stating, “V/S,” and the PF replied, “one thousand.” About 1 second later, the MCP-selected vertical speed changed to -1,000 fpm, and the PM stated, “check.” There was no communication between the flight crew for about the next 31 seconds.

At 1124:32, when the airplane was about 9.5 nm from the runway, descending through about 3,900 ft msl at an airspeed of about 185 knots and a descent rate of about 1,000 fpm, the relief FO who was observing (hereafter referred to as the observer) commented that the flight was to maintain 180 knots until 5 miles from the airport by stating, “to one eight zero five miles.” The PM responded, “ah ah ah one eight zero,” and the observer repeated, “one eight zero five miles.” At 1124:36, the PF stated, “huh?” The observer again repeated the speed to be maintained as instructed by the NorCal controller, and the PF stated, “okay one eight zero five miles.” There was no communication between the flight crew for about the next 12 seconds.

At 1124:51, when the airplane was about 8.5 nm from the runway, descending through about 3,500 ft msl at an airspeed of about 188 knots and a descent rate of about 1,000 fpm, the PF called for the landing gear to be extended. At 1124:53, the gear handle was moved to the down position, and the PM stated, “this seems a little high.” About 2 seconds later, the PF stated, “yeah,” and the PM repeated, “this should be a bit high.” About 3 seconds later, the PF stated, “do you mean it’s too high?” The PM made an unintelligible reply. At 1125:02, the PF stated, “I will descend more,” and at 1125:04, the MCP-selected vertical speed changed to -1,500 fpm. There was no communication between the flight crew for about the next 21 seconds.

At 1125:23, the PM made an unintelligible comment, followed about 6 seconds later by his comment, “ok.” At 1125:31, the PM stated, “one thousand,” and the MCP-selected vertical speed changed to -1,000 fpm. At this time, the airplane was about 6.3 nm from the runway, descending through about 2,600 ft msl at an airspeed of about 178 knots and a descent rate of about 1,500 fpm.

At 1125:36, the NorCal controller instructed the flight to contact the SFO air traffic control tower (ATCT), and the PM acknowledged the instruction. At 1125:43, the PF stated that the missed approach altitude was 3,000 ft, and about 2 seconds later, the MCP-selected altitude changed to 3,000 ft.

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<sup>11</sup> V/S pitch mode maintains the selected vertical speed until the selected altitude is captured.

<sup>12</sup> SPD A/T mode commands thrust to maintain the selected airspeed.



The airplane crossed DUYET at 1125:46, while descending through about 2,250 ft msl at an airspeed of about 176 knots and a descent rate of about 1,100 fpm. When it reached DUYET, the airplane was about 450 ft above the 1,800-ft minimum altitude depicted on the approach chart. The airplane reached a point about 5 nm from the runway at 1125:55, while descending through about 2,085 ft msl at an airspeed of about 174 knots and a descent rate of about 1,000 fpm. When it reached the 5.0 nm point, the airplane was about 400 ft above the altitude for the desired glidepath<sup>13</sup> of 3°.

At 1125:56, the PM radioed the tower controller stating the flight's position but did not receive an immediate response. About 5 seconds later, the PF called out "flaps twenty," and the PM replied, "flaps five ahh" and then "flaps twenty." At 1126:06, the flap lever was moved to the flaps 20 position as the airplane was descending through about 1,900 ft msl at an airspeed of about 175 knots and a descent rate of about 1,000 fpm, and the PF stated, "yeah." At 1126:10, the MCP-selected speed changed to 152 knots. About 2 seconds later, the PF called out "flaps thirty," and the PM replied, "speed check flaps thirty sir." At this time, the airplane's airspeed was about 174 knots, which was above the flaps 30 limit speed of 170 knots.

At 1126:25.7, the AFDS pitch mode changed to FLCH SPD, and the A/T mode changed to thrust (THR) mode.<sup>14</sup> The AFCS responded to the mode change by starting to slow the airplane to the MCP-selected speed of 152 knots and initiating a climb toward the MCP-selected target altitude of 3,000 ft, as seen in FDR-recorded AFDS pitch commands, a slight increase in thrust lever angles, and a slight pitch up. At 1126:28.3, the PM stated "flaps thirty," and at 1126:29.5, the PF made an unintelligible statement that included the word "sir." Between these two remarks, at 1126:28.8, the flap lever was moved to the flaps 30 position, and simultaneously, the autopilot (A/P) was disconnected. At this time, the airplane was about 3.5 nm from the runway, descending through about 1,500 ft msl at an airspeed of about 169 knots and a descent rate of about 1,000 fpm.

According to FDR data, the AFCS-initiated forward movement of the thrust levers that began when the A/T mode changed to THR was manually overridden, and the thrust levers were moved aft. At 1126:33, the thrust levers reached the idle position, and the A/T mode changed to HOLD. Immediately before the A/T mode change occurred, at 1126:32.5, the PM stated, "flight director," and immediately after the change, at 1126:34.0, the PF replied, "check."<sup>15</sup>

During a postaccident interview, the PF stated that he considered pressing the FLCH push-button to obtain a higher descent rate but could not recall whether he did so or not. When interviewed, none of the three flight crewmembers recalled seeing the changes to the A/T mode displayed on each primary flight display's (PFD) flight mode annunciator (FMA) that resulted from the selection of FLCH.

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<sup>13</sup> For purposes of this report, the term "desired glidepath" refers to a descent profile extending out from the 28L touchdown zone at an angle of 3° and approximately conforming to the PAPI glidepath, the ILS glideslope, and an imaginary line drawn through the ILS/LOC 28L approach step-down waypoints.

<sup>14</sup> THR A/T mode commands thrust to maintain the climb/descent rate required by the pitch mode.

<sup>15</sup> As a result of disconnecting the A/P, the status indication for the AFDS displayed near the top of both pilots' primary flight displays would have changed from "A/P" to "FLT DIR."



At 1126:36, the PM stated, “speed,” and the PF replied, “target speed one three seven.”<sup>16</sup> At 1126:38, the MCP-selected airspeed changed to 137 knots. At this time, the airplane was about 2.9 miles from the runway, descending through 1,300 ft msl at an airspeed of about 165 knots and a descent rate of about 1,000 fpm. By this point, the flight crew should have been able to clearly see the precision approach path indicator (PAPI)<sup>17</sup> lights; the PAPI indication would have been four white lights, showing that the airplane was significantly above the PAPI glidepath angle of 2.98°.

At 1126:40, the PF called out “flight director off,” and the PM replied, “okay.” According to quick access recorder (QAR) data,<sup>18</sup> at 1126:43, the left (PF’s) flight director (F/D) switch was turned off, and the right (PM’s) F/D switch remained on.<sup>19</sup> There were no further changes in the F/D switch positions for the duration of the recording. At 1126:44, the PM stated, “it’s high,” and over the next 8 seconds, the airplane’s descent rate increased from about 1,000 to 1,500 fpm. At 1126:52, the PM stated, “one thousand,” and the PF replied, “check.” At 1126:54.9, the airplane was about 2.1 nm from the runway when it descended through 1,000 ft radio altitude<sup>20</sup> (RA) at an airspeed of about 151 knots with a descent rate of about 1,500 fpm. When it descended through 1,000 ft RA, the airplane was 243 ft above the altitude for a 3° glidepath, and the PAPI indication was four white lights. Table 1 lists selected events during the last 1,000 ft of the approach.

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<sup>16</sup> Target speed for the approach was 132 knots ( $V_{ref}$ ) plus 5 knots, or 137 knots.

<sup>17</sup> A PAPI system consists of a row of four light units installed on the side of the runway that provide visual glidepath indications. The on-glidepath angle (typically about 3°) indication is two red and two white lights. Other light combinations indicate when an airplane’s position is above the glidepath (four white), slightly above (three white and one red), slightly below (three red and one white), and below (four red). According to the Federal Aviation Administration’s (FAA) *Aeronautical Information Manual*, PAPI lights are visible from about 5 miles during the day and up to 20 miles at night.

<sup>18</sup> The QAR data were used to determine the flight director switch positions because it recorded the switch positions once per second while the FDR recorded them once every 4 seconds.

<sup>19</sup> It is also possible that the PM rapidly (in less than 1 second) cycled his F/D switch off and then back on before he turned off the PF’s F/D switch.

<sup>20</sup> Radio altitude is the height of an airplane above terrain immediately below the airplane as measured by a radio altimeter.

**Table 1.** Timeline of selected events during last 1,000 ft of approach.

With respect to the PAPI lights, W=white and R=red.

Local Time	Time to impact (seconds)	Radio altitude (feet)	Airspeed (knots)	Event
1126:54.9	-55.3	1000	150.5	PAPI displaying WWWW
1126:58.6	-51.7	917	146.7	Observer: "sink rate sir"
1126:59.1	-51.2	904	147.2	PF: "yes sir"
1126:59.5	-50.8	891	147.6	PM (radio): "tower asiana two one four short final"
1127:05.1	-45.2	723	146.0	Observer: "sink rate sir"
1127:07.5	-42.8	658	144.4	Controller issues landing clearance
1127:10.8	-39.5	581	141.3	PM (radio): "cleared to land two eight left"
1127:14.8	-35.4	500	136.7	PAPI displaying WWWR
1127:15.1	-35.2	495	135.9	Airspeed drops below MCP-speed (137 knots)
1127:16.6	-33.7	465	133.8	PF: "landing checklist"
1127:17.5	-32.8	447	134.4	PM: "landing checklist complete cleared to land"
1127:19.8	-30.5	404	134.0	PM: "on glide path sir" / PAPI WWRR
1127:21.2	-29.1	378	132.8	PF: "check"
1127:23.3	-27.0	344	130.5	Airspeed drops below $V_{REF}$ (132 knots)
1127:24.1	-26.2	331	129.7	PAPI changes to WRRR
1127:31.0	-19.3	219	121.9	PAPI changes to RRRR
1127:32.3	-18.0	198	120.4	Electronic voice: "two hundred"
1127:33.6	-16.7	180	117.6	PM: "it's low"
1127:34.8	-15.5	165	119.2	PF: "yeah"
1127:39.3	-11.0	124	113.9	Sound of quadruple chime
1127:41.6	-8.7	102	111.8	Electronic voice: "one hundred"
1127:42.8	-7.5	90	109.8	PM: "speed"
1127:43.2	-7.1	86	109.1	Right engine thrust lever advanced
1127:43.7	-6.6	81	108.4	Left engine thrust lever advanced
1127:44.7	-5.6	68	106.9	A/T mode transition from HOLD to THR
1127:46.4	-3.9	46	103.6	Stick shaker engaged
1127:47.8	-2.5	29	103.8	PM: "go around"
1127:48.6	-1.7	21	104.7	Stick shaker disengaged
1127:50.3	0	5	105.5	Impact

At 1126:59, the observer stated, "sink rate sir," and the PF replied, "yes sir." At 1127:00, the PM radioed the tower controller that the flight was on short final. At 1127:05, the observer



stated, “sink rate sir” for the second time. About this time, the airplane’s descent rate momentarily reached about 1,800 fpm. Then the descent rate began to decrease, and the pitch attitude began to increase. At 1127:06, the PM stated, “cleared to land?” About 1 second later, one of the flight crewmembers stated, “sink rate.” Simultaneously, the tower controller cleared the flight to land on runway 28L. At 1127:11, the PM radioed acknowledgment of the landing clearance, and simultaneously, one of the other flight crewmembers said something unintelligible. At 1127:14.3, the PM stated, “okay.”

At 1127:14.8, the airplane was about 1.3 nm from the runway when it descended through 500 ft RA at an airspeed of about 137 knots with a descent rate of about 1,200 fpm. As shown in figure 4, which depicts a profile view of the last 40 seconds of the flight, the PAPI indication was three white lights and one red light—a slightly above glidepath indication—when the airplane descended through 500 ft RA. The thrust levers were at the idle position, and the engines’  $N_1$  speeds<sup>21</sup> were about 24%. At 1127:15.5, an electronic voice<sup>22</sup> announced “five hundred,” and about 1 second later, the PF called out “landing checklist.”

At 1127:16.8, an electronic voice announced “minimums, minimums.” At 1127:17.5, the PM stated, “landing checklist complete cleared to land.” At 1127:19.8, the PM stated, “on glidepath sir,” as the PAPI indication changed to two white and two red lights, showing the airplane’s on-glidepath position. At this time, the airplane was descending through about 400 ft RA at an airspeed of about 134 knots (where it remained for about 4 seconds) and a descent rate of about 1,100 fpm, which was above the descent rate of about 700 fpm needed to remain on glidepath. At 1127:21.2, the PF responded, “check.” There was no communication between the flight crew for about the next 11 seconds.

At 1127:23.3, the airplane’s airspeed dropped below 132 knots ( $V_{ref}$ ). At 1127:24.1, the airplane was about 1 nm from the runway at 331 ft RA, the airspeed was about 130 knots, the descent rate was about 1,000 fpm, and the PAPI indication changed to one white light and three red lights, showing the airplane’s slightly below-glidepath position. Over the next 5 seconds, the airplane’s pitch attitude increased from about 2° to 4° nose up, where it remained for about 3 seconds. At 1127:31.0, the airplane was about 0.7 nm from the runway at 219 ft RA, the airspeed was about 122 knots, the descent rate was about 900 fpm, and the PAPI indication changed to four red lights, showing the airplane’s significantly below-glidepath position. Over the next 5 seconds, the airplane’s pitch attitude increased to about 7° nose up, where it remained for about 3 seconds before continuing to increase.

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<sup>21</sup>  $N_1$  speed is the rotational speed of the engine’s low pressure spool, which includes the fan, low pressure compressor, and low pressure turbine.

<sup>22</sup> The airplane was equipped with an enhanced ground proximity warning system (EGPWS) that included an advisory callout feature that generated radio-altitude-based callouts at 500, 200, 100, 50, 40, 30, 20, and 10 ft. In addition, a callout was generated when the airplane reached the minimum descent altitude for the approach, in this case 460 ft. For more information about the EGPWS, see section 1.16.4.



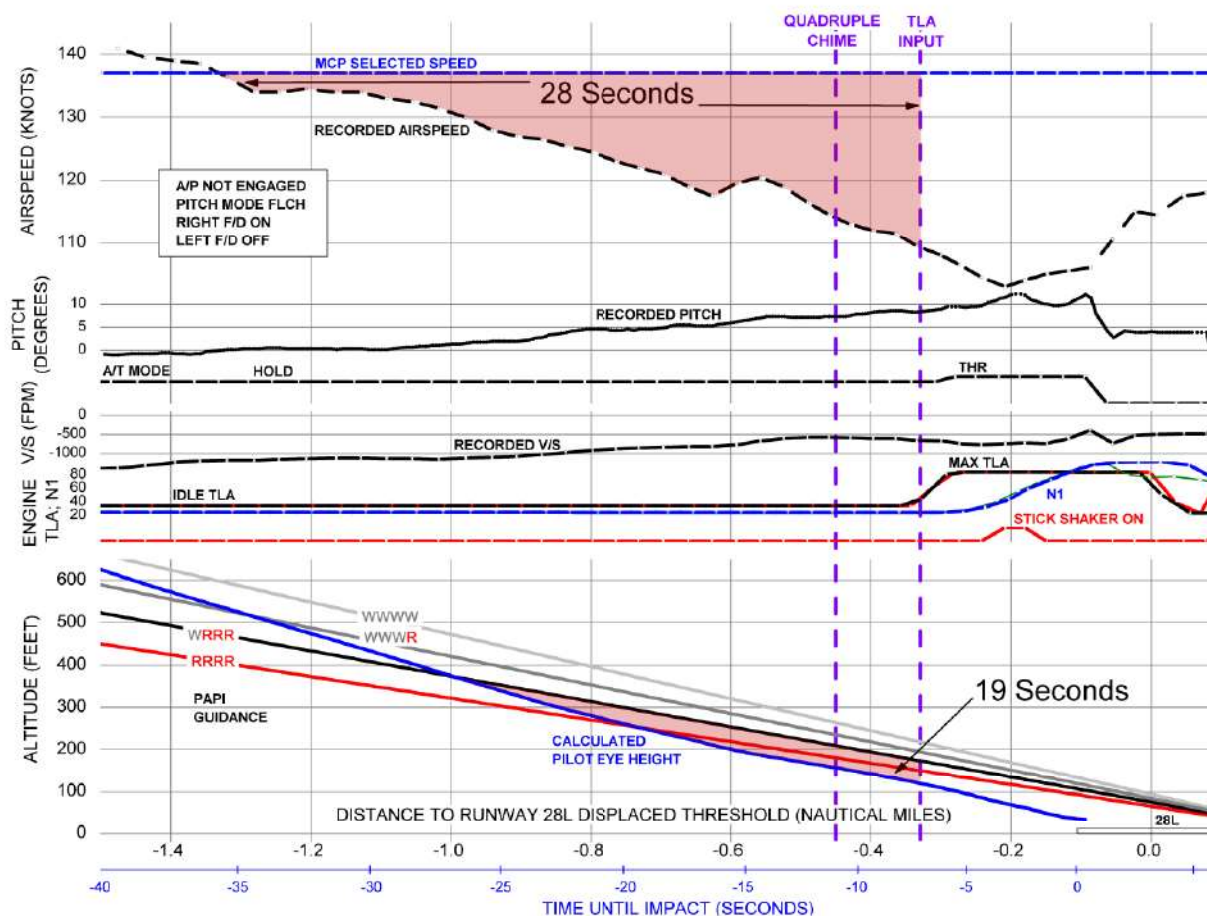


Figure 4. Profile view of the last 40 seconds of flight 214.

During a postaccident interview, the observer stated that he saw two white lights and two red lights on the PAPI as the flight descended through 500 ft RA. He recalled that beginning sometime after the airplane descended below 500 ft, he could no longer see the runway or the PAPI lights through the windscreen. The PM stated that at 500 ft RA, the airplane was slightly low, and he saw one white light and three red lights on the PAPI. The PF stated that he began to see one white light and three red lights on the PAPI at 500 ft RA and recalled thinking that if he allowed the PAPI indication to go to four red lights, he would fail his flight and would be embarrassed.<sup>23</sup> The PF pitched the airplane up to avoid going low. He stated that about that time, he “saw some light and was in blindness for a second.” The light prompted him to stop looking outside and instead look down at the instrument panel. He stated that the blindness was only momentary, and he could see the airspeed tape and noticed that the airspeed was low. The PM stated that he did not see any bright light. The PM further stated that about 200 ft RA, the airspeed was about 120 knots; he saw four red lights on the PAPI and thought perhaps the A/T was not working.

<sup>23</sup> Although the OE training flight was not a check flight, one of the PF’s previous Asiana OE instructors told investigators that a four-red PAPI indication that occurred during an OE training approach would probably be reported to Asiana training managers.

At 1127:32.3, an electronic voice announced “two hundred.” At 1127:33.6, the PM stated, “it’s low,” and the PF replied, “yeah.” At 1127:36.0, one of the flight crewmembers made an unintelligible comment. At 1127:39.3, the quadruple chime master caution alert sounded. When the alert sounded, the airplane was about 0.45 nm from the runway at 124 ft RA, the airspeed was about 114 knots, and the descent rate was about 600 fpm. At 1127:41.6, an electronic voice announced “one hundred.” At 1127:42.8, the PM stated, “speed.” Less than a second later, both thrust levers were advanced by the PM.<sup>24</sup> At 1127:44.7, the A/T mode changed from HOLD to THR. At 1127:46.4, the CVR recorded the stick shaker activating, and the lowest airspeed during the approach of about 103 knots was recorded by the FDR at 1127:46.9. At this time, the airplane was about 0.35 nm from the runway at 39 ft RA, the descent rate was about 700 fpm, the  $N_1$  speeds for both engines were increasing through about 50%, and the pitch attitude reached about 12° nose up. The airspeed then began to increase. At 1127:47.8, the PM called out, “go around,” and at 1127:48.6, the airspeed was about 105 knots, and the stick shaker stopped. The initial impact with the seawall occurred at 1127:50. At that time, the  $N_1$  speeds for both engines were increasing through about 92%, and the airspeed was about 106 knots.<sup>25</sup>

Video from airport surveillance cameras showed that following the initial impact, the tail of the airplane separated, the airplane slid along the runway, and the rear of the fuselage lifted up, tilting the airplane into about a 30° nose-down angle. The airplane pivoted counterclockwise about 330° before impacting a second time and coming to rest off the left side of the runway, about 2,400 ft from the initial seawall impact point. The airplane came to a stop about 1128:06.<sup>26</sup> Figure 5 is an aerial view of the approach end of runway 28L and the location of the wreckage. (See sections 1.15.3 and 1.15.4 for information about the evacuation and emergency response, respectively.)

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<sup>24</sup> All three flight crewmembers recalled that it was the PM who performed this action.

<sup>25</sup> When the thrust levers were fully advanced, 90%  $N_1$  compressor speeds were reached in about 6 seconds by the left engine and about 7 seconds by the right engine. The acceleration time for both engines met the 8-second performance requirement stated in the design specification.

<sup>26</sup> Because the airplane was enveloped in a cloud of dust between 1128:02 and 1128:28, it was not possible to determine from the video footage exactly when the airplane came to a stop.



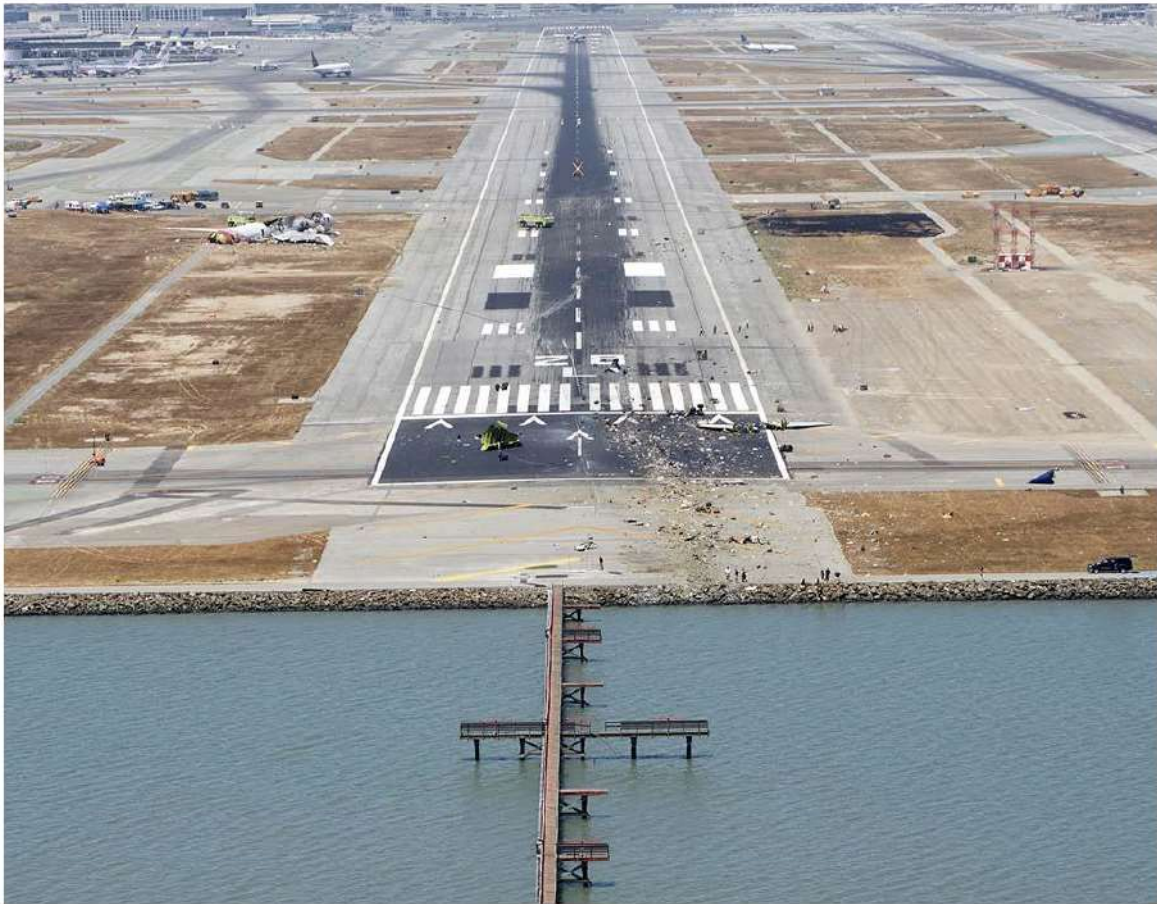


Figure 5. Aerial view of the flight 214 wreckage.

## 1.2 Injuries to Persons

Table 2. Injury chart.

Injuries	Flight Crew	Cabin Crew	Passengers	Total
Fatal	0	0	3	3
Serious	1	8	40	49
Minor	2	2	134	138
None	1	2	114	117
Total	4	12	291	307

## 1.3 Damage to Airplane

The airplane was destroyed by the impact forces and postcrash fire.