THE 21ST CENTURY  
AVIATION SECURITY AND SAFETY SYSTEM  

KEY WORDS: Aviation Safety; Aviation Security; National Security; Terrorism; Homeland Security; Flight Recorder; Remote Pilot; 9/11; Communication; ADS-B; Safelander  

I.E.E.E. LOS ANGELES CHAPTER  
COMMUNICATION, SIGNAL PROCESSING AND VEHICULAR TECHNOLOGY  
Sy Levine January 2007 sylevine1@sbcglobal.net
Some Reference URL’s

- **Safelander**
  - http://safelander.com/
- **The Remote Aircraft Flight Recorder and Advisory Telemetry System, RAFT (Patented), And It's Ability to Reduce fatal Air Accidents By 78% While Enhancing Air Space Capacity, Operational Efficiency and Aircraft Security**
- **New Statistics Show Need To Improve Air Safety Record**
  - http://www.findarticles.com/p/articles/mi_m0UBT/is_47_13/ai_57788793
- **US PATENT AND TRADEMARK OFFICE (PATENT NUMBER SEARCH):**
    - “Safelander” 7,099,752 Lenell & Levine August 29, 2006
    - “Remote, aircraft, global, paperless maintenance system” 5,974,349 Levine October 26, 1999
    - “Remote aircraft flight recorder and advisory system” 5,890,079 Levine March 30, 1999
# TABLE OF CONTENTS

A) AVIONICS & COMMUNICATION SYSTEM

B) DATA STORAGE AND COMMUNICATION BAUD RATE

C) CENTRAL GROUND-BASED PROCESSING STATION & SAFE STORAGE OF BLACK-BOX DIGITAL FLIGHT DATA & COMMUNICATION

D) LESSONS LEARNED FROM SOME OF THE CRASHES AND HOW BY FILLING IN THE EXISTING DATA VACUUM AND USING MODERN COMMUNICATION THEORY AND TECHNOLOGY WE CAN GET OUT OF THE AUTOPSY MODE OF OPERATION INTO A MODERN PROACTIVE SYSTEM TO ECONOMICALLY PREVENT CRASHES AND ENHANCE HOMELAND SECURITY

E) SOME COST AND CRASH STATISTICS

F) CONCLUSION
   1. FEATURES
   2. SALIENT BENEFITS

G) AUDIENCE PARTICIPATION
   1. QUESTIONS & ANSWERS
   2. DISCUSSION OF THE ISSUES & PRESENTATION
FIGURE 1
SAFELANDER’S AVIONICS SYSTEM

GPS/GLONASS Navigation Satellite

GPS/GLONASS Receiver

Performance and Control Sensor Data

Sensor Multiplexer Transceiver

Video Data

Acoustic Data

Remote Pilot Electronic Interface (FCU, ILS, AUTOPILOT INTERFACES)

Advisory System

Global Satellite Two-Way Secure Ciphered Digital Data Communication Link

Aircraft That Can Be Remotely Piloted
FIGURE 2
SAFELANDER COMMUNICATION SYSTEM OVERVIEW

AIRCRAFT THAT CAN BE REMOTELY CONTROLLED

GLOBAL SATELLITE TWO WAY CIPHERED DIGITAL DATA COMMUNICATION LINK

REMOTE PILOT/COPilot IN A SECURE AIRCRAFT SIMULATOR (VIRTUAL REALITY COCKPIT)

ATC/M, WEATHER, MAP, TERRAIN & SECURITY DATA

TWO WAY SECURE GROUND CIPHERED DIGITAL DATA LINK

SIMULATOR PROCESSOR
FIGURE 3  LEO SATELLITE TWO-WAY CIPHERED DIGITAL DATA & VOICE GLOBAL COMMUNICATION LINK

CGBS
Central Ground-Based Processing Station
**TABLE 1**

SAFELANDER BASIC DATA STORAGE AND RATES
25 MEGA-BAUD AND STORAGE 100 GIGA-BYTE/DAY

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER FLTS/DAY (GROWTH 2.5%/YR.)</td>
<td>38,896</td>
<td>37,944</td>
<td>35,280</td>
<td>33,600</td>
</tr>
<tr>
<td>AVERAGE FLIGHT TIME IN MINUTES</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>DFDR DATA RATE IN WORDS/SEC/AIRCRAFT</td>
<td>128</td>
<td>128</td>
<td>128</td>
<td>64</td>
</tr>
<tr>
<td>DFDR DATA WORD LENGTH IN BITS</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>DFDR DATA RATE (BITS/SEC/AIRCRAFT)</td>
<td>1,536</td>
<td>1,536</td>
<td>1,536</td>
<td>768</td>
</tr>
<tr>
<td>USING 2X (SHANNON) MULTIPLICATION YIELDS THE TOTAL DATA RATE IN MEGA-BAUD</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>DAILY STORAGE FOR ALL AIRCRAFT EASILY FITS ON A SINGLE PC DISC. IN GIGA-BYTES</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
FIGURE 4
CENTRAL GROUND-BASED PROCESSING STATION (CGBS)

Aircraft Warnings and Cautions

Air Carriers and Aircraft Manufacturers Communication Module

Antenna Control & RF and UHF Interface (Cipher, Anti-Jam & Anti-spoof Controller)

Aircraft Simulation

DATA STORAGE

GROUND BASED

ENHANCED SAFE AND SECURE “BLACK BOX” DATA

REMOTE PILOT SECURE AIRCRAFT SIMULATOR

Processor

DISPLAY & CONTROL

ATC Module
FIGURE 5
GROUND-BASED DISTRIBUTION SYSTEM

Processor

ATC/M Module

Air Carriers and Aircraft Manufacturers Communication Module

Air Carrier & Aircraft Manufacturer Facility

Emergency & Maintenance Warnings/ Cautions

Simulations

SAFELANDER (REMOTE PILOT CAPABILITY) SECURE AIRCRAFT SIMULATOR

Map Database

Topographic Database

Weather Database

TRACON ATC/M

En - route ATC/M

N

1

N

1

1
FIGURE 6  TENERIFE (583 FATALITIES) ET AL.
SAFELANDER PROVIDES AUTOMATED COLLISION AVOIDANCE
ALERTS ATC/M & CAS ENHANCED CAPABILITY DISPLAY

Note: The 583 fatality Tenerife crash was head on. This pictorial is a generic representation and shows aircraft orthogonal on the runway.

COLOR CODE TRANSLATOR

<table>
<thead>
<tr>
<th>AIRCRAFT</th>
<th>COLOR CODE</th>
<th>TRANSLATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUSELAGE</td>
<td>GREEN</td>
<td></td>
</tr>
<tr>
<td>ENGINE</td>
<td>HIGH THRUST</td>
<td>STOPPED</td>
</tr>
<tr>
<td>BRAKE</td>
<td>ON</td>
<td>LOW</td>
</tr>
</tbody>
</table>

PROJECTION

COLLISION TRAJECTORY

ESTIMATED COLLISION POINT
FIGURE 7  TENERIFE, ET AL., NO MORE
SAFELANDER PROVIDES A SAFE TRAJECTORY DISPLAY
ATC/M & CAS ENHANCED  CAPABILITY

Note: The 583 fatality Tenerife crash was head on. This pictorial is a generic representation and shows aircraft orthogonal on the runway.

COLOR CODE TRANSLATOR

<table>
<thead>
<tr>
<th>AIRCRAFT</th>
<th>FUSELAGE</th>
<th>ENGINE</th>
<th>BRAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLOR</td>
<td>GREEN</td>
<td>RED</td>
<td>BLUE</td>
</tr>
<tr>
<td>MOVE</td>
<td>PLANE MOVING</td>
<td>STOPPED</td>
<td>LOW</td>
</tr>
<tr>
<td>THRUST</td>
<td>HIGH THRUST</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>GEAR</td>
<td>DOWN</td>
<td>UP</td>
<td></td>
</tr>
</tbody>
</table>

SAFELANDER IEEE PRESENTATION
FIGURE 8  SAFELANDER CAS DISPLAY

PROJECTED COLLISION TRAJECTORY BASED ON AIRCRAFT TRACK VECTORS

- VELOCITIES (Vn, Ve, Vh)
- PRESENT POSITIONS
- PROJECTED POSITIONS

TRANSLATOR

LANDING GEAR

DOWN  UP

NOTE: ONE LANDING GEAR IS DOWN

FLASHING PROBLEM ICONS
LANDING GEAR

15 MINUTES OF FUEL REMAINING

PROJECTION
TRAJECTORIES

SAFE

COLLISION

ESTIMATED COLLISION POINT
FIGURE 9 SAFELANDER PROVIDES AN AIRCRAFT DATA SUPERHIGHWAY (SIMILAR TO THE INTERNET) THAT RESPECTS AN AIR CARRIER’S PRIVILEGED DATA

AC# = AIR CARRIER (1,2,...)  
P# = PLANE (1,2,...)  

ONLY AC1 DATA

GPS SAT

LEO DATA LINK SAT

AC1/P1

AC2/P1

ONLY AC2 DATA

AC# = AIR CARRIER (1,2,...)  
P# = PLANE (1,2,...)  

ATC/M & CAS

CGBS

PRIVILEGED AIR CARRIER CIPHERED DATA

A,B,C,D,... DATA

P1  P2

A  B

C  D

P1  P2
FIGURE 10
CHRONOLOGY OF SATELLITE PER FLIGHT COMMUNICATION COSTS

AVERAGE $ COST PER PLANE PER AVERAGE FLIGHT
(AVG. FLT. TIME = 95 MIN.)

$cost/plane/avg.flt.

2008 ESTIMATE $9.1/FLT.

YEAR

### TABLE 2  WORLDWIDE AIR CARRIER FATALITIES AND FATAL ACCIDENTS


<table>
<thead>
<tr>
<th>FATAL ACCIDENT TYPE/QTY</th>
<th>Total Fatalities</th>
<th>Total %Fatalities</th>
<th>US Operators Fatalities</th>
<th>US %Fatalities</th>
<th>RAFT Fatalities</th>
<th>RAFT %Fatalities</th>
<th>RAFT Operators Fatalities</th>
<th>RAFT %Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled Flight Into Terrain (CFIT)</td>
<td>2396</td>
<td>32.01%</td>
<td>312</td>
<td>19.68%</td>
<td>479</td>
<td>17.04%</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>- CFIT Only On Approach</td>
<td>957</td>
<td>12.79%</td>
<td>0</td>
<td>0.00%</td>
<td>191</td>
<td>6.81%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Loss of Control In Flight</td>
<td>2228</td>
<td>29.77%</td>
<td>482</td>
<td>30.41%</td>
<td>1114</td>
<td>39.62%</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>In Flight Fire</td>
<td>760</td>
<td>10.15%</td>
<td>340</td>
<td>21.45%</td>
<td>152</td>
<td>5.41%</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Sabotage</td>
<td>607</td>
<td>8.11%</td>
<td>254</td>
<td>16.03%</td>
<td>546</td>
<td>19.43%</td>
<td>229</td>
<td></td>
</tr>
<tr>
<td>Mid-air Collision</td>
<td>506</td>
<td>6.76%</td>
<td>0</td>
<td>0.00%</td>
<td>101</td>
<td>3.60%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hijack</td>
<td>306</td>
<td>4.09%</td>
<td>38</td>
<td>2.40%</td>
<td>275</td>
<td>9.79%</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Ice and/or Snow</td>
<td>162</td>
<td>2.16%</td>
<td>57</td>
<td>3.60%</td>
<td>32</td>
<td>1.15%</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Landing</td>
<td>128</td>
<td>1.71%</td>
<td>3</td>
<td>0.19%</td>
<td>26</td>
<td>0.91%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Windshear</td>
<td>119</td>
<td>1.59%</td>
<td>37</td>
<td>2.33%</td>
<td>36</td>
<td>1.27%</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Fuel Exhaustion</td>
<td>113</td>
<td>1.51%</td>
<td>0</td>
<td>0.00%</td>
<td>23</td>
<td>0.80%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other Unknown</td>
<td>111</td>
<td>1.48%</td>
<td>17</td>
<td>1.07%</td>
<td>22</td>
<td>0.79%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Runway Incursion</td>
<td>45</td>
<td>0.60%</td>
<td>45</td>
<td>2.84%</td>
<td>5</td>
<td>0.16%</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Rejected Take Off (RTO)</td>
<td>3</td>
<td>0.04%</td>
<td>0</td>
<td>0.00%</td>
<td>1</td>
<td>0.02%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL FATALITIES</strong></td>
<td><strong>7484</strong></td>
<td><strong>100%</strong></td>
<td><strong>1585</strong></td>
<td><strong>100%</strong></td>
<td><strong>2812</strong></td>
<td><strong>100%</strong></td>
<td><strong>521</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% REDUCTION IN FATALITIES</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FATAL ACCIDENT TYPE/QTY</td>
<td>Fatal Accidents</td>
<td>% Fatal Accidents</td>
<td>US Fatal Accidents</td>
<td>US % Fatal Accidents</td>
<td>RAFT Fatal Accidents</td>
<td>% Fatal Accidents</td>
<td>RAFT Operators Accidents</td>
<td>% Fatal Accidents</td>
</tr>
<tr>
<td>Controlled Flight Into Terrain (CFIT)</td>
<td>36</td>
<td>26.47%</td>
<td>4</td>
<td>11.76%</td>
<td>7</td>
<td>15.32%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Loss of Control In Flight</td>
<td>38</td>
<td>27.94%</td>
<td>11</td>
<td>32.35%</td>
<td>19</td>
<td>40.43%</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>In Flight Fire</td>
<td>4</td>
<td>2.94%</td>
<td>2</td>
<td>5.88%</td>
<td>1</td>
<td>1.70%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sabotage</td>
<td>5</td>
<td>3.68%</td>
<td>1</td>
<td>2.94%</td>
<td>5</td>
<td>9.57%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mid-air Collision</td>
<td>2</td>
<td>1.47%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hijack</td>
<td>8</td>
<td>5.88%</td>
<td>1</td>
<td>2.94%</td>
<td>7</td>
<td>15.32%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ice and/or Snow</td>
<td>5</td>
<td>3.68%</td>
<td>3</td>
<td>8.82%</td>
<td>1</td>
<td>2.13%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Landing</td>
<td>9</td>
<td>6.62%</td>
<td>1</td>
<td>2.94%</td>
<td>2</td>
<td>3.83%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Windshear</td>
<td>3</td>
<td>2.21%</td>
<td>1</td>
<td>2.94%</td>
<td>1</td>
<td>1.91%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fuel Exhaustion</td>
<td>7</td>
<td>5.15%</td>
<td>0</td>
<td>0.00%</td>
<td>1</td>
<td>2.98%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other Unknown</td>
<td>14</td>
<td>10.29%</td>
<td>6</td>
<td>17.65%</td>
<td>3</td>
<td>5.96%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Runway Incursion</td>
<td>4</td>
<td>2.94%</td>
<td>4</td>
<td>11.76%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Rejected Take Off (RTO)</td>
<td>1</td>
<td>0.74%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td>0.00%</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL FATALITIES</strong></td>
<td><strong>136</strong></td>
<td><strong>100%</strong></td>
<td><strong>34</strong></td>
<td><strong>100%</strong></td>
<td><strong>47</strong></td>
<td><strong>100%</strong></td>
<td><strong>8</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% REDUCTION FATAL ACCIDENTS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
WITHOUT SAFELANDER IT WILL RECUR
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
WITH SAFELANDER WE HAVE A COST EFFECTIVE SOLUTION TO OUR SAFETY AND SECURITY
On August 29, 2006, the United States Patent Office issued US Patent Number 7,099,752 named SAFELANDER, which supplements the onboard pilot of an aircraft with a ground-based remote-pilot/copilot safety system. Such a system could have prevented attacks such as 9/11.

When the 9/11 planes deviated from their approved flight plans, the remote-pilot/copilot (in a secure, high-fidelity, virtual-reality aircraft simulator) using ciphered telemetry could have taken control of all of the deviant aircraft and landed them safely at airports in sparsely populated areas.

The highly-qualified remote-pilot can safely fly the aircraft in congested air space, via ciphered radio telemetry to the aircraft and air traffic controllers.

The advanced telemetry permits the remote-pilot/copilot to control an aircraft just as if he/she were the onboard pilot.

SAFELANDER eliminates many problems associated with the recovery and utilization of onboard flight data recorders/black-boxes since all communications and flight data are safely stored, in real-time on the ground, in the computer’s memory for post flight analysis.
The SAFELANDER remote-pilot/copilot has many advantages over the current day onboard-only pilot approach, since the remote-pilot/copilot is not subject to loss of oxygen, extreme G forces, temperature, smoke, passenger disturbances and terrorists.

The ground-based cockpit virtual-reality simulator minimizes problems associated with pilot disorientation, poor visibility, weather, runway selection and ground incursions, which have resulted in numerous fatal accidents.

From a safety standpoint, the remote-pilot/copilot can also communicate directly with flight operations, emergency and security personnel, as well as with the aircraft manufacturer’s design/engineering experts on how best to handle an aircraft operation problem thereby preventing the loss of life.

Additionally, a single remote-pilot could concurrently and safely fly a plurality of airplanes using well known aircraft spacing/separation.
IN CONCLUSION SAFELANDER:

1. increases homeland security by safely, quickly and remotely diverting aircraft away from major edifices and energy facilities (in many instances fighter aircraft do not have the response time necessary to prevent a future variant of 9/11, etc.);
2. increases aircraft security by reducing the incentives to hijack an aircraft;
3. increases aircraft safety because of fewer crashes by providing expert systems which share in real-time a comprehensive set of flight and ground data, crash avoidance strategies and can remotely control/land an aircraft should the flight crew become disabled (e.g.: golfer-Payne Stewart/1999, Helios Flight 522/2005, Swissair Flight 111/1999, crash etc);
4. saves lives and reduces injuries;
5. enables free-flight great circle routes and thereby decreases flying time and saves fuel;
6. prevents aircraft from flying into restricted airspace by diverting aircraft to non-restricted areas;
IN CONCLUSION SAFELANDER:

7. reduces personnel costs by eliminating the onboard copilot in aircraft (e.g., cargo flights);
8. reduces aircraft avionics by removing the electronics required for an onboard copilot;
9. reduces the aircraft weight by removing the onboard copilot’s seat and controls;
10. reduces aircraft fuel cost per pound of payload by eliminating items unrelated to payload;
11. reduces the maintenance costs for aircraft avionics and mechanical systems by having less of them;
12. reduces aircraft purchase costs by eliminating items unrelated to payload;
13. reduces insurance costs and liability claims, and
14. increases aircraft payload by utilizing the space and weight gained from the reduction of aircraft avionics, copilot seat & controls, and the onboard copilot.
ALWAYS SMILE WHILE YOU’RE FLYING SINCE EVERYTHING IS UNDER CONTROL
CONCLUDING REMARKS

➤ QUESTIONS

➤ OPEN DISCUSSION OF THE ISSUES & PRESENTATION
Back-up Material 9/11/2001

Notice that the departure and crash times would have permitted a single remote pilot in a ground-based simulator to take real-time control of each aircraft and sequentially land them at sparsely populated landing sites:

On September 11, 2001 the following occurred:

<table>
<thead>
<tr>
<th>AIRCRAFT</th>
<th>CAR.</th>
<th>FLT</th>
<th>DEPARTURE</th>
<th>CRASH</th>
<th>SITE</th>
<th>FATALITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOEING 767</td>
<td>AAL</td>
<td>11</td>
<td>7:59 AM</td>
<td>8:46 AM</td>
<td>WTC</td>
<td>92</td>
</tr>
<tr>
<td>BOEING 767</td>
<td>UAL</td>
<td>175</td>
<td>7:58 AM</td>
<td>9:03 AM</td>
<td>WTC</td>
<td>65</td>
</tr>
<tr>
<td>BOEING 757</td>
<td>AAL</td>
<td>77</td>
<td>8:10 AM</td>
<td>9:43 AM</td>
<td>PENTAGON</td>
<td>64</td>
</tr>
<tr>
<td>BOEING 757</td>
<td>UAL</td>
<td>93</td>
<td>8:44 AM</td>
<td>10:10 AM</td>
<td>PA.</td>
<td>44</td>
</tr>
</tbody>
</table>

A total of 265 died aboard aircraft and about 2700 died on the ground.

The cost of the disaster was estimated at over 10 billion dollars which is more than five times the estimated 2 billion dollars required to make SAFELANDER operational.