Inadvertent Slide Deployment

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Contents

The following topics will be covered in this presentation:

- **Introduction -** *Why do we need to address this subject ?*

- **Causal Factors -** *Which factors contribute?*

- **Door Lever Design -** *Man-Machine Interface?*

- **Defense Strategies -** *How can we reduce the number of incidences?*

- **Discussion**

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Introduction

Inadvertent Slide Activation

is a safety hazard to people approaching the aircraft from the outside (such as catering personnel)

is costly because……..

Introduction

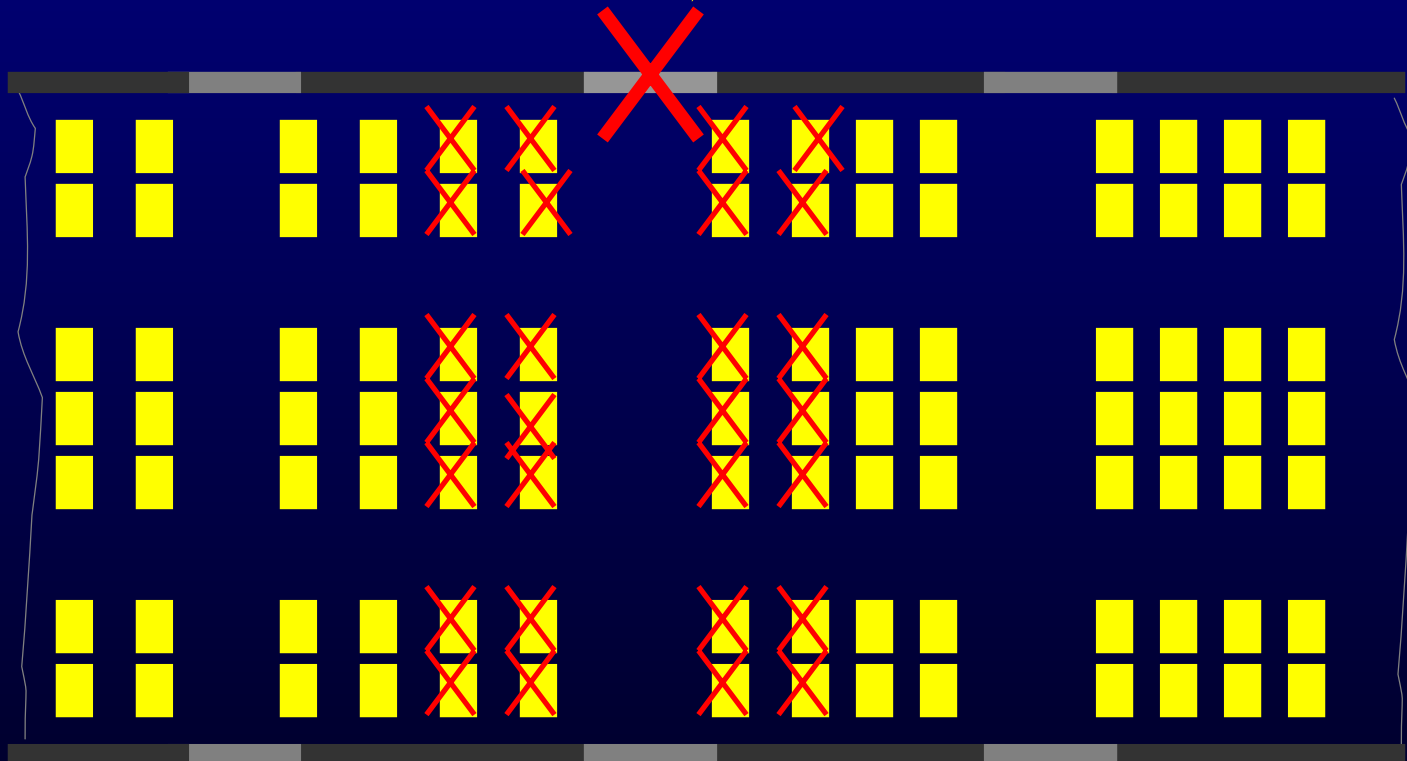1)   **Cost for Slide Replacement:**

Typically USD 5.000,-

Introduction

2) Blocking of Seats ➡ Removal of passengers:
➡ Revenue and Image loss

(according MEL seats across entire cabin, halfway to the next exit have to be blocked)

Introduction

3) Time delay:

Replacing a slide – if possible at all (outstations!) – takes time.

Example: recent incident on Boeing 767 caused 5 hour delay.

Introduction

4) Other Cost:

There was one report were an inadvertently deployed slide was ingested into a running engine, causing substantial damage.

This incident cost the airline approximately USD 650.000,-

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Introduction

Slide deployment needs to be based on

- **number of door operations (i.e. flight cycles)**
- **per aircraft type or per similar arming/disarming mechanisms (e.g. A319/320/321)**

to see if there is an ergonomic issue.

Suggestion: *set up your own database*

Introduction

Who deploys slides inadvertently?

- cabin crew
- maintenance personnel
- catering personnel
- pilots
(- passengers)

When are slides deployed inadvertently?

- when door is opened, but also inflight cases
- during transit stops, when some slides are disarmed and others are not
- one case reported: immediately after block-off

Contents

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Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

Traditional Approach: blame the cabin crew
- lack of attention
- lack of attitude/motivation to do a proper job

➡ **In some instances: dismissal of cabin crew**
- fight with Unions. Legal cost ?

➡ **Incidences were scared cabin crew would disarm a slide in an emergency**

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Causal Factors

Fortunately, this traditional approach has been replaced by a systemic approach with a more appropriate blame-free environment in most airlines.

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Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

■ **Fatigue**

■ **………..**

In the beginning, it was believed that

- fatigue

- sector length and

- time of day

play a major role, however...

Causal Factors

- **Many deployments were on B767 with long sectors and a comparatively low frequency of door operation.**

- **Many deployment were also reported on A320 with short sectors and high frequency of door operation.**

- **Cabin crews of short-range aircraft typically also undergo long duty periods, resulting in fatigue.**

- **However, e.g. B737 shows an excellent history**

- **The same cabin crews typically operate different types: long-range and short-range aircraft.**

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Causal Factors

Result:

- ■ **Fatigue / Disturbed Sleep Patterns,**

- ■ **Sector-length and**

- ■ **Time of the day**

are obviously <u>not</u> the driving factors

Causal Factors

According to a scientific study, error-producing conditions result in an increase in error-likelihood by following factors:

Condition (by William, 1988)	Factor
Unfamiliarity with task………………………………	17
Time shortage………………………………………	11
Poor Signal to Noise Ratio………………………....	10
Poor interface design……………………………	8
Designer-user mismatch……………………………	8
Irreversibility of errors……………………………	8
Information Overload……………………………....	6
Negative transfer between tasks…………………...	5
Misperception of risk……………………………....	4
Poor feedback from system………………………...	4
Inexperience (not lack of training)………………...	3
Inadequate checking……………………………....	3
Educational mismatch of person with task……….	2
Disturbed sleep patterns………………………....	1,6
Hostile Environment………………………………	1,2
Monotony and boredom……………………………	1,1

Causal Factors

Additional factors:

■ **Fatigue**

■ **Distraction under time pressure**

■

■

■

■

■

Causal Factors

Condition	Factor
Unfamiliarity with task……………………………..	17
Time shortage………………………………………..	11
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Monotony and boredom…………………………..	1,1

Causal Factors

Distraction under <u>time pressure</u> is a common problem. Some <u>examples</u>:

■ **Passengers getting up early, pouring towards an entrance in an attempt to get out quickly**

■ **Passengers requesting transit information or requesting coats**

■ **Requests by the cockpit crew**

➡ **Distraction under time pressure seems to be a number-one causal factor**

Causal Factors

Additional factors:

- ■ Fatigue
- ■ Distraction under time pressure
- ■ Out-of-Flow Situations
- ■
- ■
- ■
- ■
- ■

Causal Factors

Typical examples of situations, were door operation gets "out of flow":

- ■ **Opening doors again for cabin ventilation, while waiting on ground** *(e.g. ATC slot delay)*

- ■ **Re-opening of doors because passengers have been left outside**

- ■ **Last minute catering arriving at the aircraft - *"knocking-on-the-door syndrome"***

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Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

- Fatigue
- Distraction under time pressure
- Out-of-Flow Situations
- Non-adherence to procedures

Causal Factors

Typical examples are:

- Forgetting / carry out sloppy cross-check procedure

- Not assigning door-responsibilities

- Forgetting command to *"disarm slides"*

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Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

- ■ **Fatigue**
- ■ **Distraction under time pressure**
- ■ **Out-of-Flow Situations**
- ■ **Non-adherence to procedures**
- ■ **Unfamiliarity with the task**
- ■
- ■
- ■

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Causal Factors

In aviation, heavy training efforts (such as Door Training mandatory by JAR-OPS for all flight crew and cabin crew). People not necessarily receiving any training are e.g. catering personnel.

■ It seems that not only inexperienced crew members deploy slides ! *"Even the best people can make the worst mistakes!"*

Research shows that <u>unfamiliarity with a task</u> results in a very high chance of producing errors (see next slide).

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Causal Factors

Condition	Factor
Unfamiliarity with task……………………………	17
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Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

- ■ Fatigue
- ■ Distraction under time pressure
- ■ Out-of-Flow Situations
- ■ Non-adherence to procedures
- ■ Unfamiliarity with the task
- ■ Environmental
- ■

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Causal Factors

■ **Frozen condensation water leading to a stuck girt bar. Despite of "*slide-disarmed*"-indication slides were still armed.**

■ **.......others ?**

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Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

- ■ Fatigue
- ■ Distraction under time pressure
- ■ Out-of-Flow Situations
- ■ Non-adherence to procedures
- ■ Unfamiliarity with the task
- ■ Environmental
- ■ Others
- ■

Causal Factors

- **Maintenance Personnel (often have to work under extreme time pressure)**

- **Passengers operating exits in an attempt to practice newly acquired knowledge**

- **One report of an inflight deployment on a B747-400. Cause was never determined but three possible scenarios were discussed (including a child putting the hand through an opening and pulling the firing lanyard)**

- **Ferry flights: ferry pilots are recruited from within the pilot community. Pilots in general are unfamiliar with the task**

Causal Factors

■ **Communication - Problem:**

One incident was reported where a First Officer tried to help a cabin crew with the door. He asked her (moving the arms up and down) do disarm the slide. This up-down was interpreted as a request to "recycle" the slide selector by the cabin crew. When the pilot opened the door, the slide blew.

One girt bar indicator was hidden by a small milk can. When the slide was armed, only one yellow could be seen – as a result the FA asked the pilot for support.

Causal Factors

Which are the factors that contribute to inadvertent slide deployment ?

- ■ **Fatigue**
- ■ **Distraction under time pressure**
- ■ **Out-of-Flow Situations**
- ■ **Non-adherence to procedures**
- ■ **Unfamiliarity with the task**
- ■ **Environmental**
- ■ **Others**
- ■ **Interface Man-Machine (ergonomic issues)**

Contents

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Door Lever Design

- Previous 7 classes of causal factors are independent of aircraft type

- The investigation revealed that certain type aircraft (B767 and A320) are significantly more frequently involved in inadvertent slide activations than others

- Obviously, door handle design has an impact

  In the following, some aircraft doors are discussed

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Door Lever Design

- **B737**
- **B767**
- **B777**
- **A320**
- **A330 / A340**

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Door Lever Design

Door Lever Design

1. Close Door

2. Red Flag

3. Engage Girtbar

4. Slide Armed

Door Lever Design

Is the system error tolerant?

YES - cabin crews who open doors with the slides
still armed will feel
- greater resistance
- can see that the girt bar is still engaged
- can open the door quite a bit without triggering the
   slide.

Drawbacks ?

- Slides will not disarm when door is opened from the
   outside.

- Lengthy procedure to arm / disarm

Door Lever Design

Drawbacks ?

- Slides will not disarm when door is opened from the outside.

- Reports that FAs hurt their back when   aircraft went through a sharp turn while engaging the girt bar (FA fell over).

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Door Lever Design

Door Lever Design

Slides are always shot when the door is opened, so lets take a look at the disarm/ opening procedure:

Disarm and open door:
- Lift cover
- Pull small green lever towards you
- Pull large handle towards you

When slide is armed, a "yellow flag" cautions the cabin crew against door operation:

■ Yellow flags of smaller sizes were produced and showed to be less effective.

■ Sometimes, the yellow flag breaks away.

■ How effective is a flag that is present for the entire flight ?

Door Lever Design

Girt bar indicator window located close to the floor

Door Lever Design

Is the system error tolerant?

1) NO - once the door lever is pulled slightly towards the body, a spring will assist the door opening. Because the door weight is reduced by the weight of the slide, the door will be raised very quickly !

Spring to assist door opening

Door Lever Design

Is the system error tolerant?

2) NO - door operation and slide arm/disarm is made
very easy.

- **Close proximity of the levers**
- **Similar directions of movement (same plane**
of movement, basically towards the body)

➡ **Danger of confusing the levers.**
"Yellow Flag" caution is obviously not efficient.

➡ **Slide selector not in line of sight -**
easy to oversee

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Door Lever Design

In general has a good history:

■ **Initially some design flaws**

■ **Door lever and slide selector spaced far apart**

■ **Slide selector in line of sight**

■ **Still problems with girt bar indicator: shows yellow even with disarmed slide**

Door Lever Design

Frame around viewing window sometimes detaches

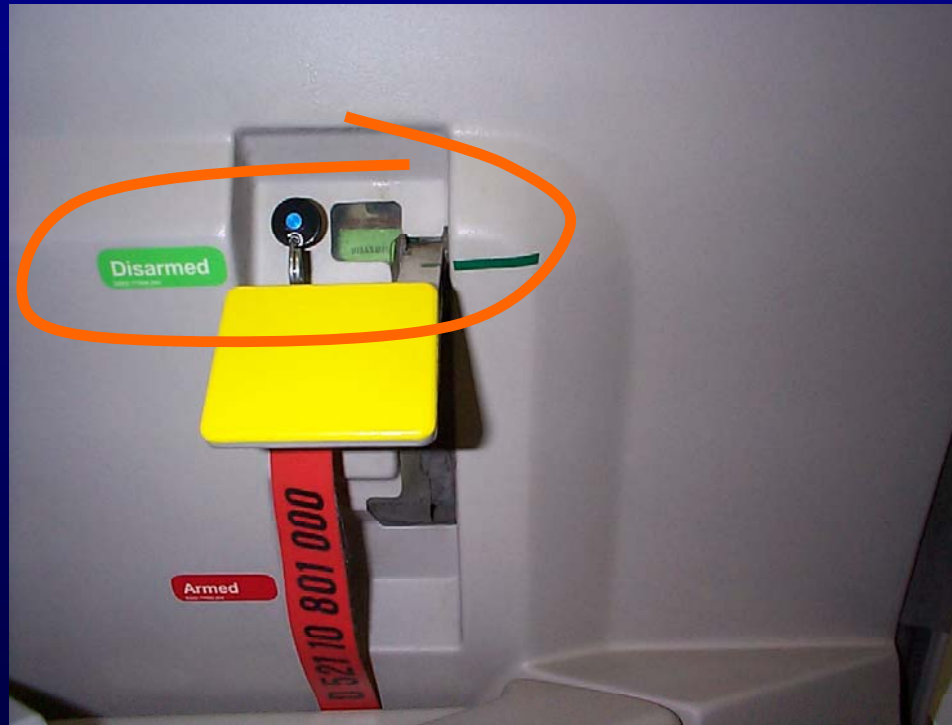# Door Lever Design

A 320

Door Lever Design

- Has a known history of inadvertent slide deployments.

- Mainly short sectors, therefore, frequent door operation. However, there are other types operating short sectors, as well.

- One operator reported that there never were any problems but when A320 was introduced, deployments increased significantly during the first year.

Door Lever Design

Door Lever Design

When the slide is armed, the indication window shows "armed" while the placard next to the slide selector shows disarmed - causes confusion among cabin crews.

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Statistics   Index

Door Lever Design

Contents

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Defense Strategies

One operator reported that according their procedures cabin crews are <u>not allowed to open any door</u>, except during an emergency

Defense Strategies

1. Fatigue
2. Distraction under time pressure
3. Out-of-Flow Situations
4. Non-adherence to procedures
5. Unfamiliarity with the task
6. Environmental
7. Others
8. Man-Machine-Interface

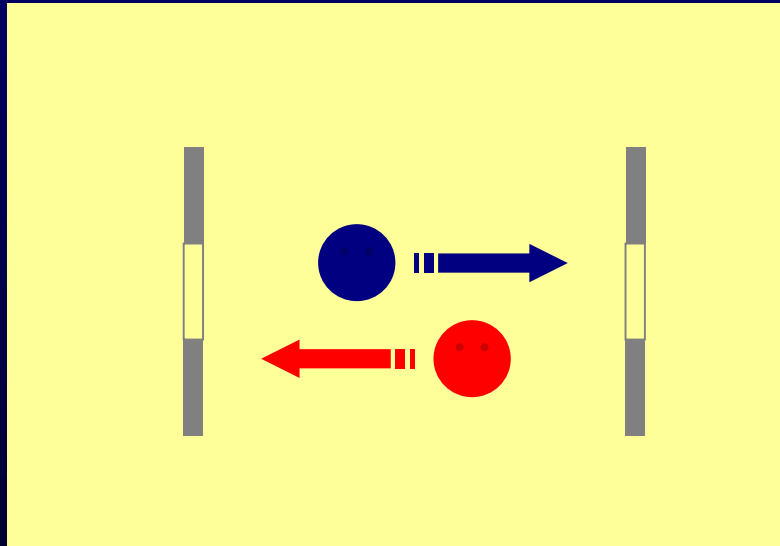*Lauda-air*

Defense Strategies

There is nothing new that we can do to reduce fatigue and sleep-pattern disturbances among our crews:

- ■ **Establish crew rests**

- ■ **Good rostering**

- ■ **Don´t necessarily always push the roster to the legal limits**

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Defense Strategies

1. Implement Cross-Check Procedure:

"Cabin Crew disarm, crosscheck and report"

- ■ **Will only help when FA forgets to disarm slide**

- ■ **Not of any help when FA grabs wrong lever**

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Defense Strategies

2. Don´t wait for FSB-Sign to disarm slides:

Disarm slides when reaching final parking position

Defense Strategies

3. Additional Measures:

- **Make announcements to remain seated**

- **Hand out coats prior to operating doors**

- **Don´t bother with passenger requests at this stage.**

- **Why not use a checklist ?**

Normal Operation:
Slide Selector ....UP
Door Lever.........PULL

Defense Strategies

Recent Example:

- **Boeing 767 reaching parking position after 11 hour flight**

- **It took pilots longer than normal to establish alternate electrical power prior engine shut-down**

- **Seat belt signs already turned off at this stage.**

- **Result: Passengers pouring to the exits, waiting to get out**

Fortunately, know slide was shot – disarm command was given and flight attendants worked according procedure.

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Defense Strategies

- ◼ **Arm doors only after aircraft has started to move**

- ◼ **Make it a standard procedure to call for *"disarm slides"* whenever door have to be opened**

- ◼ **Why not use a checklist ?**

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Defense Strategies

■ **Training: explain why certain procedures are in use and why they have to be followed strictly**

Defense Strategies

- ◼ **Regular duty-assignment on all types to maintain a good working knowledge**

- ◼ **Don´t assign door responsibility to a person that is not familiar with the task (catering, maintenance, Air Marshalls)**

- ◼ **Use uniform wording / labeling across all fleets:**

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Defense Strategies

Arm /disarm

Park/flight

Doors automatic/ manual

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Defense Strategies

ARM   *DisARM*

- ■ These words don´t relate to the flight phase

- ■ These words are not everyday school English

- ■ These words are similar except for the *"dis"* (remember: affirmative vs. negative was changed to affirm vs. negative)

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Defense Strategies

Suggestion:

Flight   Park

Defense Strategies

- ■ **System knowledge (tell the cabin crew about frozen water)**

- ■ **Maintain a good reporting system**

- ■ **Talk to the airframe manufacturer and try to implement a design change**

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Defense Strategies

- ■ **Not only train cabin crews, but also maintenance personnel (recurrent training!)**

- ■ **Work out procedures for ferry flights**

- ■ **Work out procedures for flights with less than nominal crew:**

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Defense Strategies

Example:

Number of Cabin Crew:		**8 -12**
P	FA 1	Door 1L
O	FA 3	Door 1R
S	FA 4	Door 2L
I	FA 5	Door 2R
T	FA 7	Door 3L
I	FA 8	Door 3R
O	FA 6	Door 4L
N	FA 9	Door 4R

Defense Strategies

Example:

| Number of Cabin Crew:			**7**
P	FA 1		Door 1L
O	**AbP**	(if available)	Door 1R
S	FA 4		Door 2L
I	FA 5		Door 2R
T	FA 7		Door 3L
I	FA 8		Door 3R
O	FA 6		Door 4L
N	FA 9		Door 4R

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Defense Strategies

■ **Inform cabin crews about the specific peculiarities of the different aircraft types**

■ **Talk to regulatory agencies**

■ **Participate in Design-Reviews with manufacturers:**
  - try to improve designs
  - try to improve the indication system

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Defense Strategies
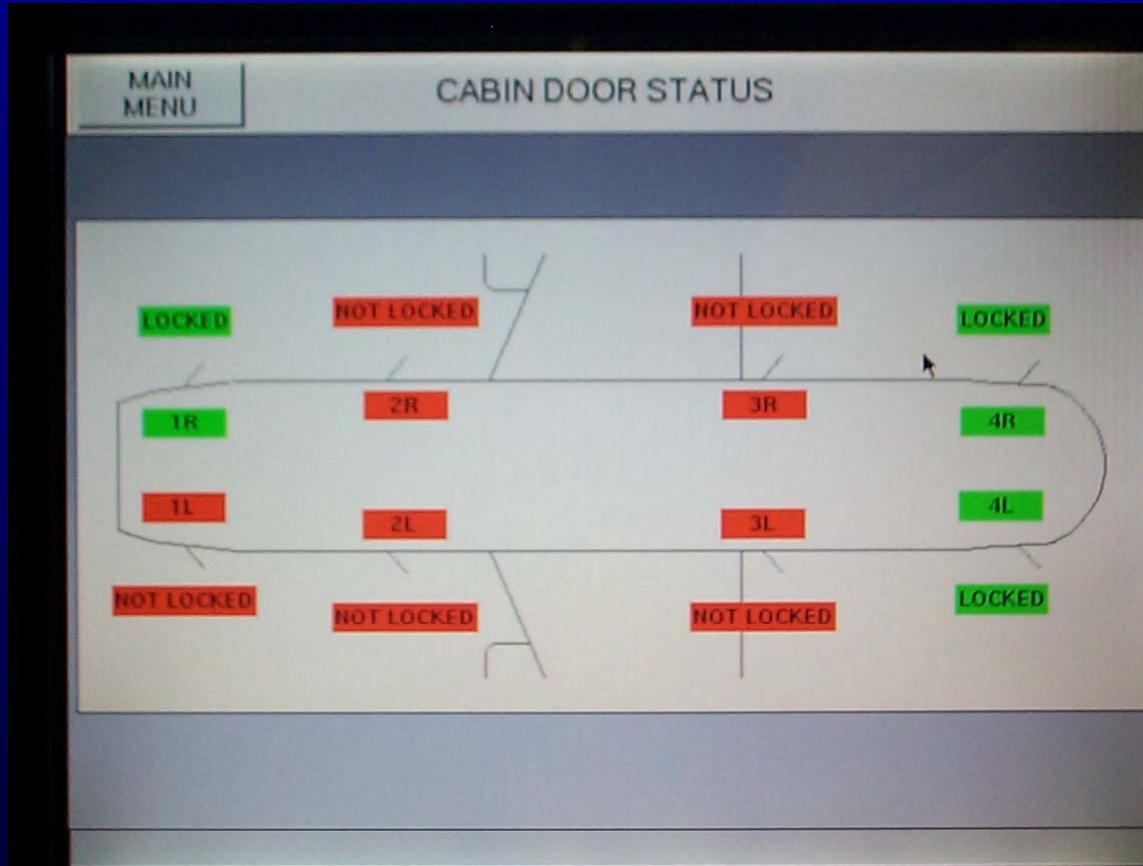
Only door status but no information about status of slides

Defense Strategies

■ <u>FUTURE</u>: same door / slides operation across different types ?

Have you ever felt you needed instructions on how to open someone elses front door? Probably not-door operation in houses is standardized!

■ Overthink present design philosophies – example *"ejection seat"*

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Defense Strategies

■ **Overthink present design philosophies – example *"ejection seat", "fire handle"***

Separate slide selector that only when actuated deploys a slide. Is it really necessary that a slide deploys automatically when the door is opened? Would a FA be able to fire the slide with a separate handle (has to do it anyways, if automatic deployment fails)?

Some Hard Facts

1998:   **B767: 3 deployments**

B777: 2 deployments

- **- B737:**   **nil deployments**
- **- B767:**   **1 deployment every 750 cycles**
- **- B777:**   **1 deployment every 500 cycles**

1999:   **B767: 1 deployments**

B777: 2 deployments

- **- B737:**   **nil deployments**
- **- B767:**   **1 deployment every 2500 cycles**
- **- B777:**   **1 deployment every 800 cycles**

Some Hard Facts

2000:   **B767: 1 deployment**
                                        B777: 0 deployments

 - B737:   **nil deployments**
 - B767:   **under investigation**
 - B777:   **nil deployments**

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Some Hard Facts

Costs:

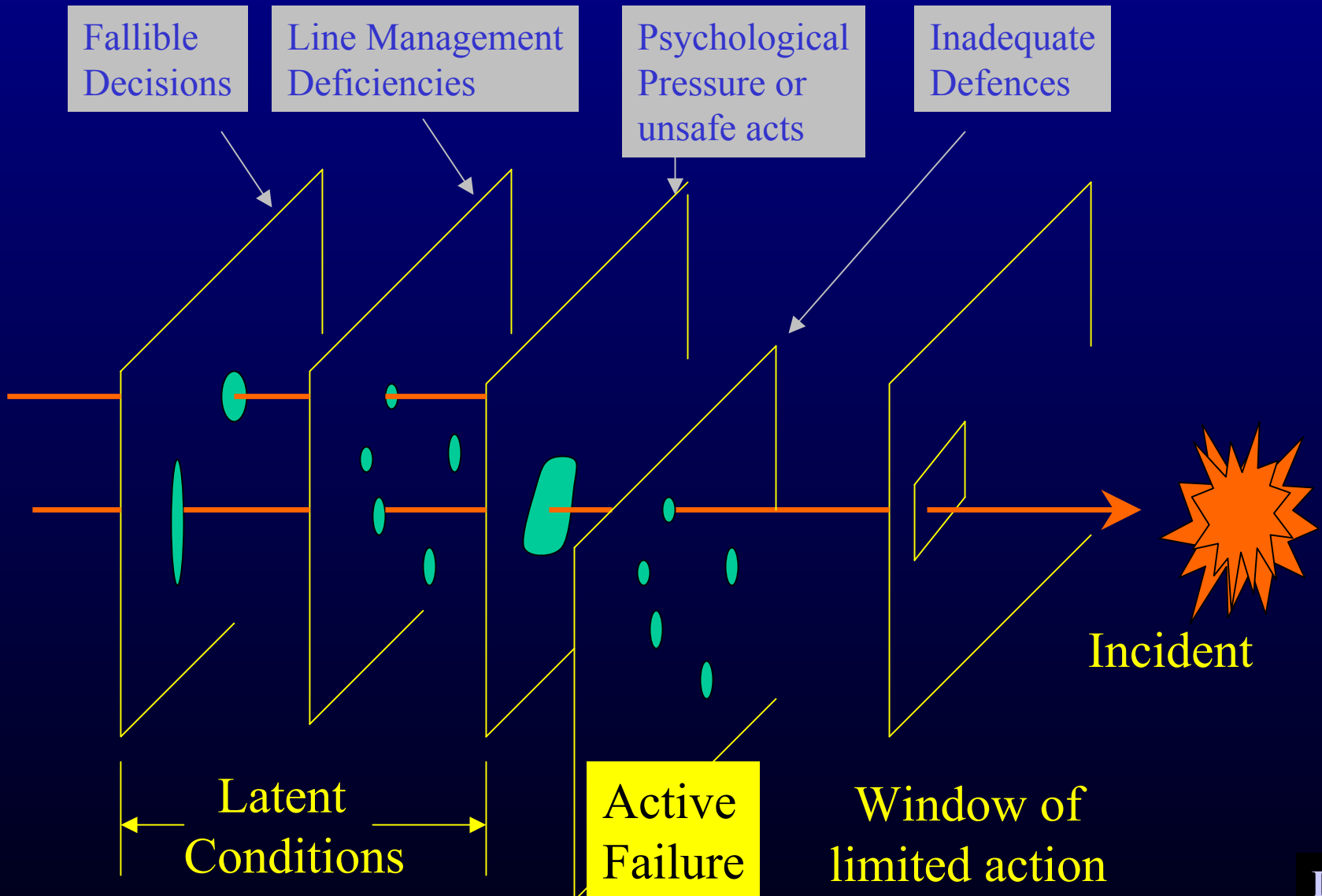**One operator reported NZ$ 172.500,- in direct Costs.**

Summary

Inadvertent slide deployments are usually caused by a number of factors, most but not all independent of aircraft type. Cabin crew work at the "front end" and will therefore usually make the active failure.

We need a systemic approach to correctly identify the weak spots...

Causal Factors

Fallible Decisions

Line Management Deficiencies

Psychological Pressure or unsafe acts

Inadequate Defences

Incident

Latent Conditions

Active Failure

Window of limited action

Thank you

to all individuals of several airlines worldwide who shared information and therefore contributed to this presentation.

Further Information

If you have further requests or suggestions please contact

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I suggest we share a database so to be able to present "hard facts" to manufacturers. Deployments per Aircraft Type, based on Flight Cycles, complemented with short narratives. Thank you for your support.

Paper Version – also on this CD-ROM
CD-ROM – see Desk to your left