

# Cosmic Ray Exposure Control For Air Crew

## - A Danish Solution -



# Introduction

Peer Widar  
Wollenberg

Retired Airline Captain  
Founder, Vice Chairman of **GlobaLog**

Erik Friis Mondorf

Technology Attache to the  
Royal Danish Embassy, Tokyo, Japan.

USA 1984 **Dr. Edward T. Bramlitt** proposes:

*"Classify flight crews as radiation workers"*

.... Petition denied!

.... Reason: Individual radiation accounting would be an unnecessary burden for the airline industry

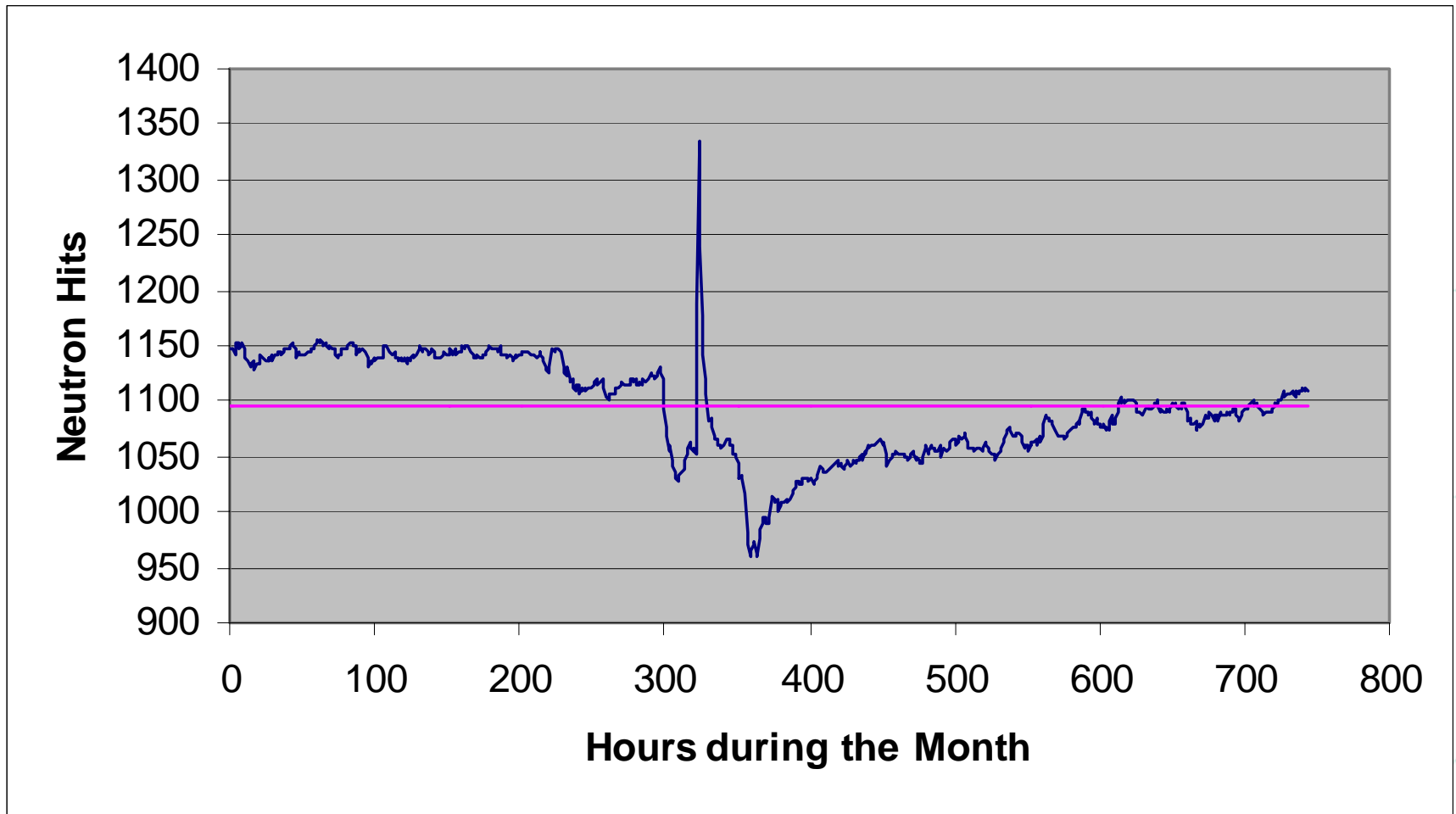
Europe 1996: "Safe" limit for radiation workers goes from 50 mSv annually down to 20.

Is there such a thing as a "safe" limit? – How would it be defined?

- EU Council Directive 96/29/Euratom:
- *“ Each Member State shall make arrangements for ... crew who are liable to be subject to exposure of more than 1 mSv per year.”*
- *“- to assess the exposure ...”*
- *“- to take into account ... when organizing working schedules ...”*
- *“- to inform ... of the health risks ...”*
- *“- to apply Article 10 to female air crew”  
(1 mSv during the pregnancy)*

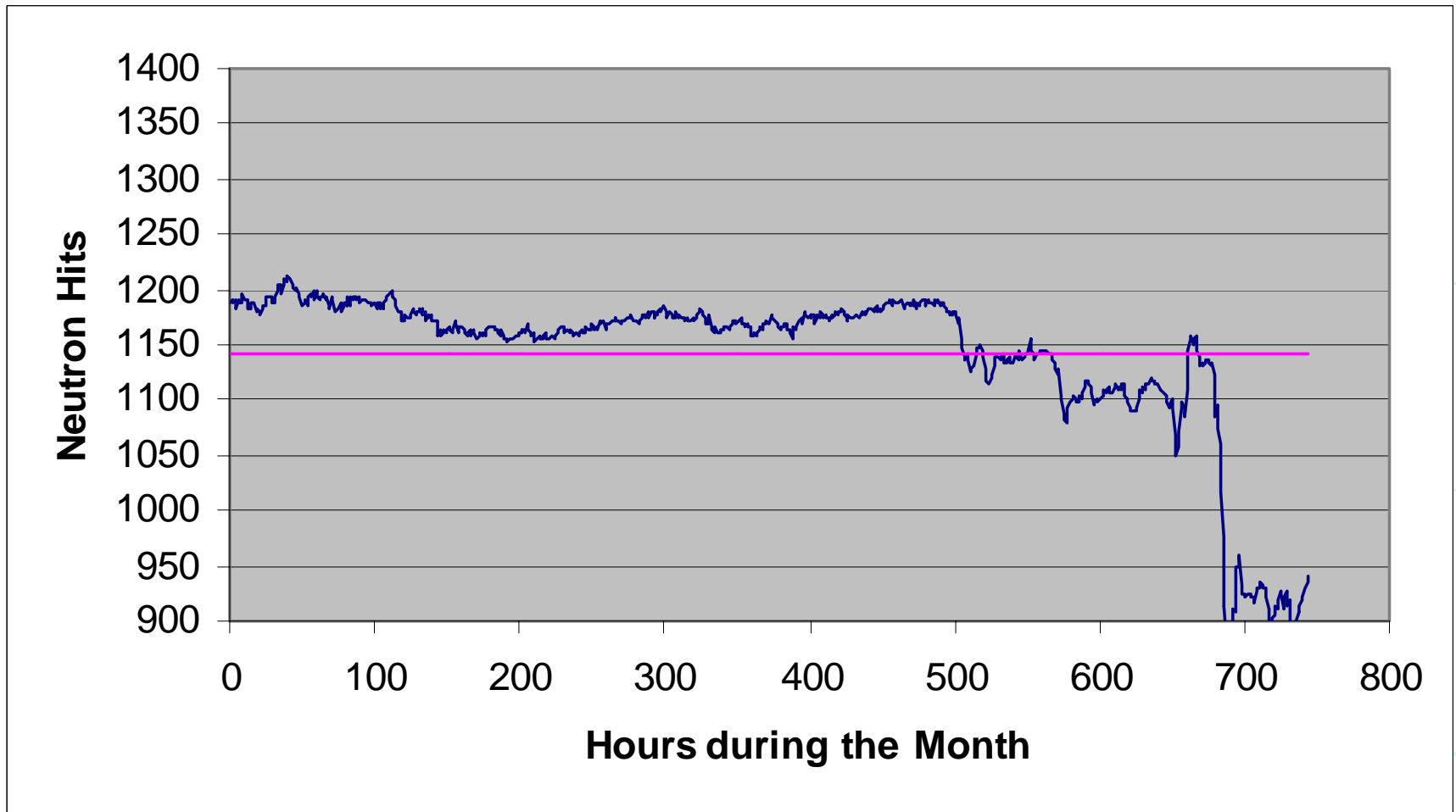
# Cosmic Radiation July 2000

## Hour by Hour



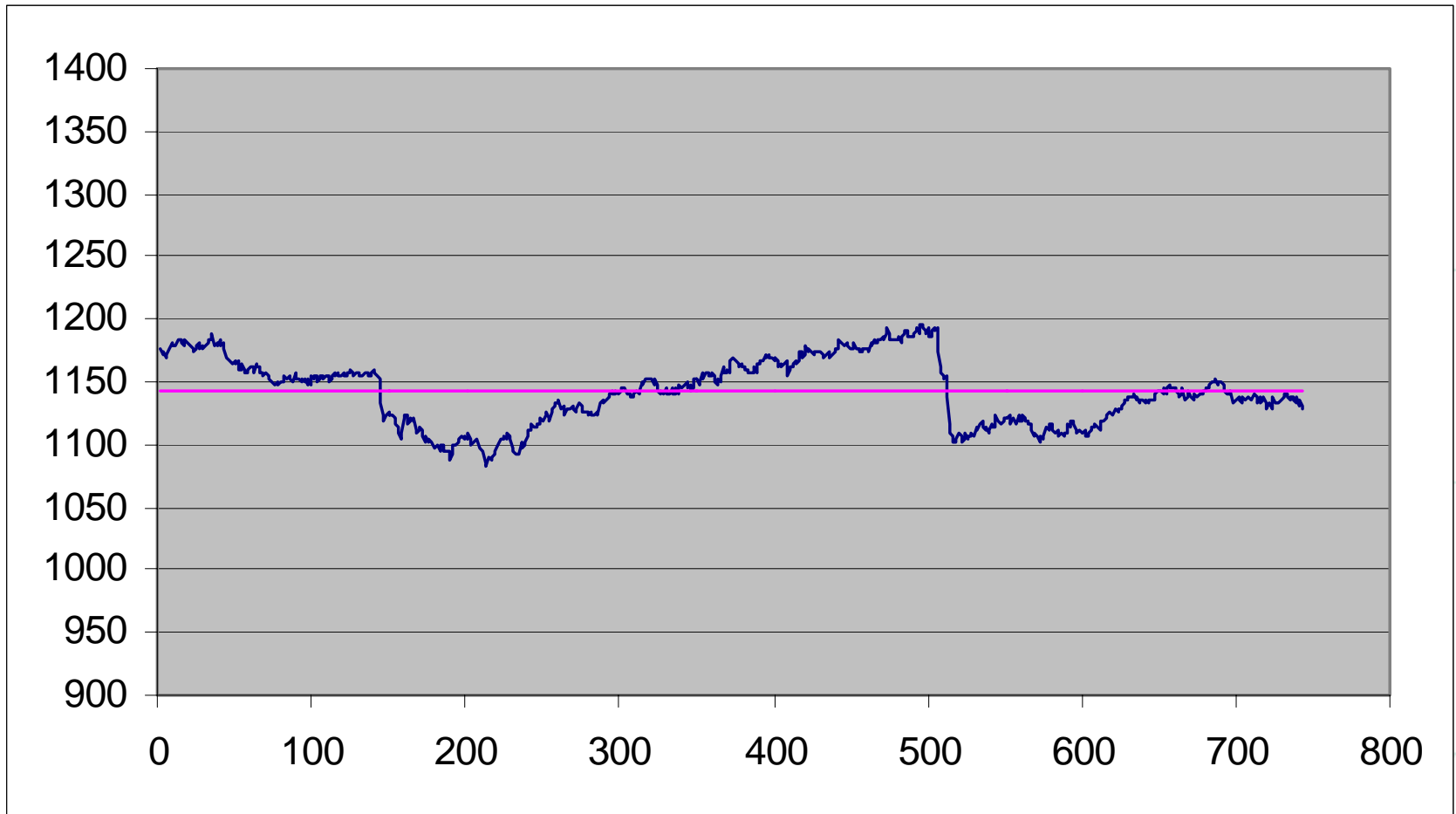
# Cosmic Radiation October 2003

## Hour by Hour



# Cosmic Radiation January 2004

## Hour by Hour



# Same Flight on Two Different Days

- Copenhagen – Los Angeles
  - Departure: 14th July 2000 07:00
  - Duration of Flight: 11:00
  - **Radiation 80  $\mu\text{Sv}$**  **(68  $\mu\text{Sv}$ )**
- 
- Copenhagen – Los Angeles
  - Departure: 15th July 2000 19:00
  - Duration of Flight: 11:00
  - **Radiation 53  $\mu\text{Sv}$**  **(68  $\mu\text{Sv}$ )**



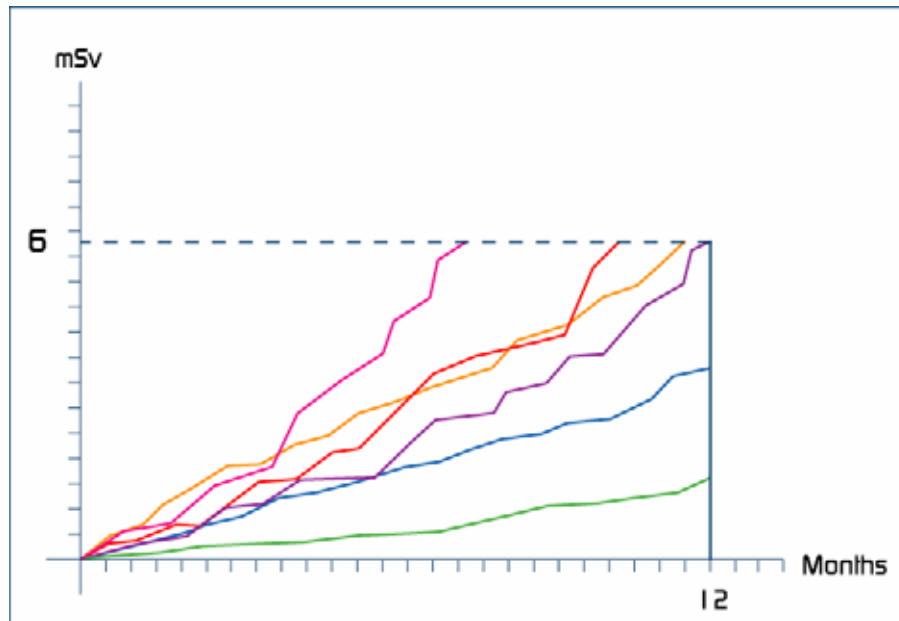
# Calculating Average per Flight Hour

Copenhagen – Los Angeles	11.00 Hrs	79.6 $\mu$ Sv
Copenhagen – Johannesburg	11.10 -	41.7 -
:	:	:
:	:	:
:	:	:
<u>Copenhagen – Hongkong</u>	<u>10:20 -</u>	<u>57.2 -</u>
Total	91:20 Hrs	310.5 $\mu$ Sv
<b><u>Average per Hour</u></b>		<b><u>3.4 <math>\mu</math>Sv</u></b>

# Same Time - Two Different Flights

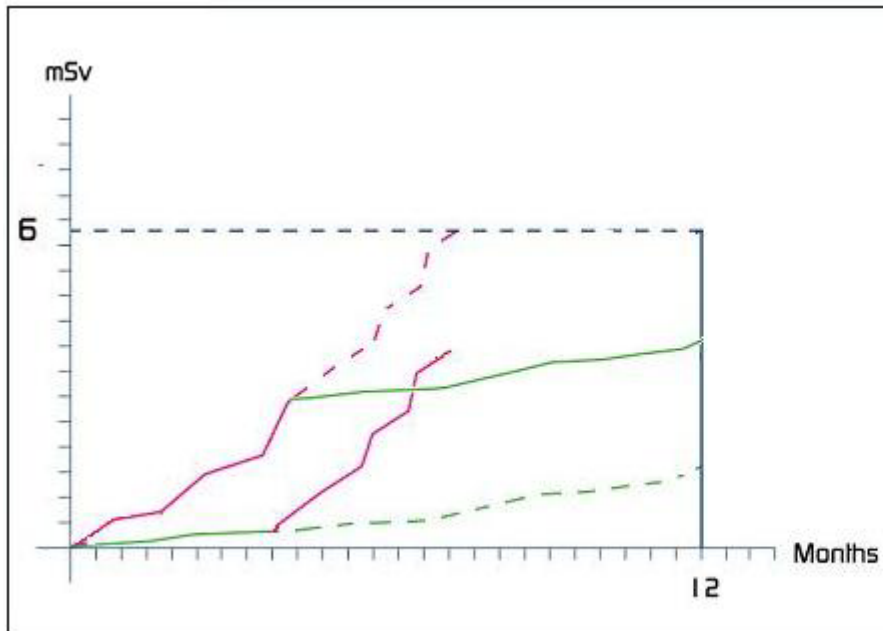
- Copenhagen – Los Angeles
  - Departure: 14th July 2000 07:00
  - Duration of Flight: 11:00
  - **Radiation 80  $\mu\text{Sv}$**  **(37  $\mu\text{Sv}$ )**
- 
- Copenhagen – Johannesburg
  - Departure: 14th July 2000 07:00
  - Duration of Flight: 11:00
  - **Radiation 42  $\mu\text{Sv}$**  **(37  $\mu\text{Sv}$ )**

# From Average to Individual



- Shift from average to individual readings
- Individual radiation accounts for each crew member
- Knowing exactly how close people are to being *too* close
- Eliminate both the risk of legal liability and maintain production capacity

# From Average to Individual



- Shift from average to individual readings
- Individual radiation accounts for each crew member
- Knowing exactly how close people are to being *too* close
- Eliminate both the risk of legal liability and maintain production capacity

Receiver: XXX Airways, YYY Airport

Att.: Operations, [ope@xxxair.com](mailto:ope@xxxair.com)

Sender: **GlobaLog**, [crewwatch@globalog.biz](mailto:crewwatch@globalog.biz)

Place/Date: **Copenhagen, 02.04.2002 11:16 UTC**

### **Please be aware**

that the following Flight Crew Members have exceeded an effective dose of Cosmic Radiation of 1.5 mSv during the preceeding three months of flight:

Allan Simms 211072-1591

Christina Bierman Abbott 010570-1658

This note is **not** required by law, but it is suggested that the flight schedule for these crew members is ajusted in order to avoid them exceeding 6.00 mSv during the year.

This can be done by having the crew members execute their duties on flights

1. **at lower altitudes**
2. **at lower latitudes**
3. **on shorter flight legs.**

Receiver: XXX Airways, YYY Airport  
Att.: Operations, [ope@xxxair.com](mailto:ope@xxxair.com)

Sender: GlobaLog, [crewwatch@globalog.biz](mailto:crewwatch@globalog.biz)  
Place/Date: Copenhagen, 02.01.2002 12:26 UTC

### Distribution of Flight Crew Members

Group 1 (0 – 1 mSv):	21	1.43%
Group 2 (1 – 2 mSv):	63	4.29%
Group 3 (2 – 3 mSv):	129	8.79%
Group 4 (3 – 4 mSv):	243	16.55%
Group 5 (4 – 5 mSv):	675	45.98%
Group 6 (5 – 6 mSv):	331	22.55%
Group 7 (more than 6 mSv):	6	0.41%
Total:	1468	100.00%

### Specification of Group 7 Crew Members

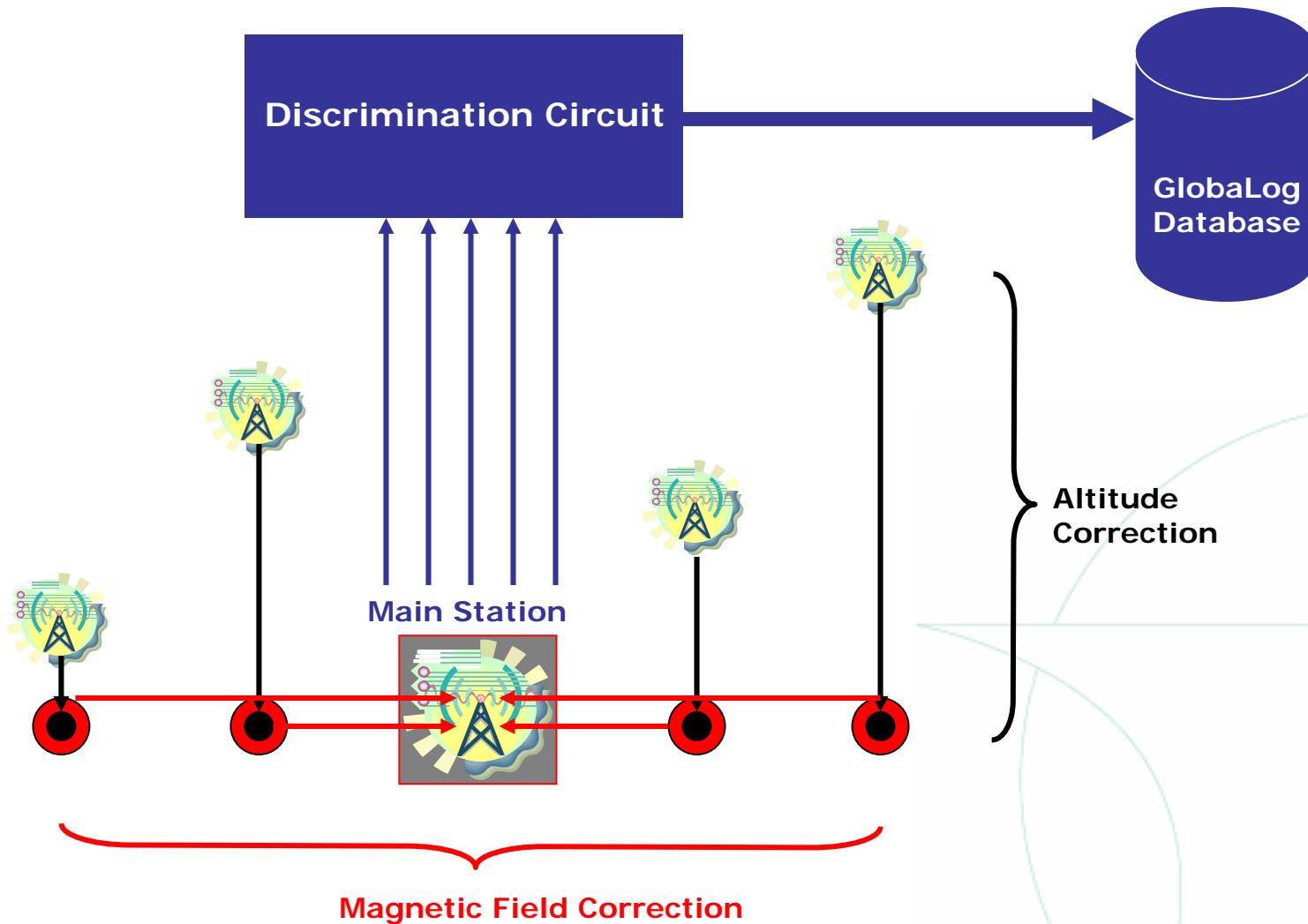
Ann Cathrine Boston	120379-1234	6.03 mSv
Peter Osborne	260575-3365	6.28 mSv
Michael Andersson	061274-2257	6.44 mSv
Helen Bunner	170878-4412	6.94 mSv
Allan Simms	211072-1591	7.54 mSv
Christina Bierman Abbott	010570-1658	7,93 mSv

# How is it done?

End of Flight - Captain reports to operations: "*Aircraft on Block*"

- *On-Block-Time* filed by operations
- The system observes automatically that *ANOTHER FLIGHT IS TERMINATED*
- The *FLIGHT DATA* are automatically transferred to the system for processing
- The *CREWLIST* is automatically transferred to the system
- The flight is now reconstructed *MINUTE-BY-MINUTE* and the radiation dose is calculated for each minute taking into account:
  - *RADIATION STRENGTH AT THIS MINUTE*
  - *ALTITUDE OF THE AIRCRAFT*
  - *GEOGRAPHIC POSITION OF THE AIRCRAFT*
- The accumulated radiation dose for the flight is *DISTRIBUTED TO EACH OF THE CREWMEMBERS*
- Using his/her *PERSONAL USERNAME AND PASSWORD* the exposure is now *available to each individual crew member*

# Radiation Data Acquisition





Pilots Logbook

Name: AAA 1  
 Globalog-ID: 96597865  
 Authenticity code: F2JFGH4XCDV982

Date flown Entry date Type	AC Type AC Reg. Flight no.	P.I.C. F.O. F.E.	ATD - ATA TKOF - TDWN DEP - ARR	Total time IFR time VFR time P.I.C time	Acc. Acc. Acc. Acc.	Day Night Ldg Day Ldg Night	Acc. Acc. Acc. Acc.	Single Eng. Multi Eng.	Acc. Acc.	Glider Balloon Airship Ultra light	Acc. Acc. Acc. Acc.	Simulator Instructor Student Dual	Acc. Acc. Acc. Acc.	Cosmic Radiation C.R. Accumulated C.R. Calendar Year C.R. Last 12 Months C.R. Since Decl. Date
02-01-2003 23-04-2004 Route	757-200 OY-GRL GL785	DDD AAA -	10:25 - 15:35 11:21 - 15:33 CPH - UAK	5:10 5:10 0:00 0:00	5:10 5:10 0:00 0:00	5:10 0:00 1 0	5:10 0:00 1 0	0:00 5:10	0:00 5:10	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	27.45 $\mu$ Sv 27.45 $\mu$ Sv 27.45 $\mu$ Sv 27.45 $\mu$ Sv - $\mu$ Sv
02-01-2003 23-04-2004 Route	757-200 OY-GRL GL786	AAA DDD -	16:45 - 20:53 16:51 - 20:48 UAK - CPH	4:08 4:08 0:00 4:08	9:18 9:18 0:00 4:08	0:40 3:28 0 1	5:50 3:28 1 1	0:00 4:08	0:00 9:18	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	25.57 $\mu$ Sv 53.02 $\mu$ Sv 53.02 $\mu$ Sv 53.02 $\mu$ Sv - $\mu$ Sv
04-01-2003 23-04-2004 Route	757-200 OY-GRL GL6985	EEE AAA BBB	11:25 - 13:35 11:40 - 13:30 CPH - GNB	2:10 2:10 0:00 0:00	11:28 11:28 0:00 4:08	2:10 0:00 1 0	8:00 3:28 2 1	0:00 2:10	0:00 11:28	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	8.51 $\mu$ Sv 61.54 $\mu$ Sv 61.54 $\mu$ Sv 61.54 $\mu$ Sv - $\mu$ Sv
04-01-2003 23-04-2004 Route	757-200 OY-GRL GL6986	BBB EEE AAA	15:52 - 17:39 15:56 - 17:33 GNB - CPH	1:47 1:47 0:00 0:00	13:15 13:15 0:00 4:08	0:14 1:33 0 1	8:14 5:01 2 2	0:00 1:47	0:00 13:15	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	6.81 $\mu$ Sv 68.35 $\mu$ Sv 68.35 $\mu$ Sv 68.35 $\mu$ Sv - $\mu$ Sv
04-01-2003 23-04-2004 Route	757-200 OY-GRL GL6987	AAA BBB EEE	18:59 - 21:01 19:10 - 20:58 CPH - GNB	2:02 2:02 0:00 2:02	15:17 15:17 0:00 6:10	0:00 2:02 0 1	8:14 7:03 2 3	0:00 2:02	0:00 15:17	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	8.24 $\mu$ Sv 76.59 $\mu$ Sv 76.59 $\mu$ Sv 76.59 $\mu$ Sv - $\mu$ Sv
04-01-2003 23-04-2004 Route	757-200 OY-GRL GL6988	EEE AAA BBB	22:22 - 00:21 22:27 - 00:11 GNB - CPH	1:59 1:59 0:00 0:00	17:16 17:16 0:00 6:10	0:00 1:59 0 1	8:14 9:02 2 4	0:00 1:59	0:00 17:16	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	0:00 0:00 0:00 0:00	7.57 $\mu$ Sv 84.16 $\mu$ Sv 84.16 $\mu$ Sv 84.16 $\mu$ Sv - $\mu$ Sv

## Cabin Crew Logbook

Name: JJJ 4  
 Globalog-ID: 974106874  
 Authenticity code: C2JFGH4XCDV982

Date flown	Flight no.	DEP - ARR	ATD - ATA	AC Reg	AC Type	P.I.C.	Total Time	Total Time Acc.	Cosmic Radiation per Flight	Cosmic Radiation Acc.	Cosmic Radiation Calender	Cosmic Radiation 12 Months	Cosmic Radiation Since Decl.
05-07-2003	GL781	07:34 - 11:55	CPH - SFJ	OY-GRN	A-330-200	III	4:21	4:21	24.84 $\mu$ Sv	24.84 $\mu$ Sv	24.84 $\mu$ Sv	24.84 $\mu$ Sv	- $\mu$ Sv
05-07-2003	GL782	13:39 - 18:01	SFJ - CPH	OY-GRN	A-330-200	-	4:22	8:43	25.57 $\mu$ Sv	50.41 $\mu$ Sv	50.41 $\mu$ Sv	50.41 $\mu$ Sv	- $\mu$ Sv
10-07-2003	GL781	07:21 - 11:46	CPH - SFJ	OY-GRN	A-330-200	-	4:25	13:08	25.64 $\mu$ Sv	76.05 $\mu$ Sv	76.05 $\mu$ Sv	76.05 $\mu$ Sv	- $\mu$ Sv
10-07-2003	GL782	13:11 - 17:32	SFJ - CPH	OY-GRN	A-330-200	AAA	4:21	17:29	25.75 $\mu$ Sv	101.80 $\mu$ Sv	101.80 $\mu$ Sv	101.80 $\mu$ Sv	- $\mu$ Sv
11-07-2003	GL781	07:16 - 11:32	CPH - SFJ	OY-GRN	A-330-200	GGG	4:16	21:45	24.95 $\mu$ Sv	126.75 $\mu$ Sv	126.75 $\mu$ Sv	126.75 $\mu$ Sv	- $\mu$ Sv
11-07-2003	GL782	13:17 - 17:34	SFJ - CPH	OY-GRN	A-330-200	-	4:17	26:02	25.52 $\mu$ Sv	152.27 $\mu$ Sv	152.27 $\mu$ Sv	152.27 $\mu$ Sv	- $\mu$ Sv
16-07-2003	GL781	07:27 - 11:53	CPH - SFJ	OY-GRN	A-330-200	-	4:26	30:28	25.90 $\mu$ Sv	178.17 $\mu$ Sv	178.17 $\mu$ Sv	178.17 $\mu$ Sv	- $\mu$ Sv
16-07-2003	GL782	13:24 - 17:45	SFJ - CPH	OY-GRN	A-330-200	AAA	4:21	34:49	25.64 $\mu$ Sv	203.81 $\mu$ Sv	203.81 $\mu$ Sv	203.81 $\mu$ Sv	- $\mu$ Sv
30-07-2003	GL781	07:24 - 11:49	CPH - SFJ	OY-GRN	A-330-200	GGG	4:25	39:14	25.33 $\mu$ Sv	229.13 $\mu$ Sv	229.13 $\mu$ Sv	229.13 $\mu$ Sv	- $\mu$ Sv
30-07-2003	GL782	13:12 - 17:34	SFJ - CPH	OY-GRN	A-330-200	-	4:22	43:36	25.44 $\mu$ Sv	254.57 $\mu$ Sv	254.57 $\mu$ Sv	254.57 $\mu$ Sv	- $\mu$ Sv
31-07-2003	GL781	07:22 - 11:43	CPH - SFJ	OY-GRN	A-330-200	-	4:21	47:57	25.51 $\mu$ Sv	280.08 $\mu$ Sv	280.08 $\mu$ Sv	280.08 $\mu$ Sv	- $\mu$ Sv
31-07-2003	GL782	13:10 - 17:37	SFJ - CPH	OY-GRN	A-330-200	FFF	4:27	52:24	25.93 $\mu$ Sv	306.01 $\mu$ Sv	306.01 $\mu$ Sv	306.01 $\mu$ Sv	- $\mu$ Sv
27-08-2003	GL785	07:40 - 12:20	CPH - UAK	OY-GRL	757-200	CCC	4:40	57:04	29.38 $\mu$ Sv	335.39 $\mu$ Sv	335.39 $\mu$ Sv	335.39 $\mu$ Sv	- $\mu$ Sv
27-08-2003	GL786	17:59 - 22:04	UAK - CPH	OY-GRL	757-200	EEE	4:05	61:09	24.53 $\mu$ Sv	359.92 $\mu$ Sv	359.92 $\mu$ Sv	359.92 $\mu$ Sv	- $\mu$ Sv
04-09-2003	GL781	07:15 - 11:39	CPH - SFJ	OY-GRN	A-330-200	III	4:24	65:33	25.78 $\mu$ Sv	385.70 $\mu$ Sv	385.70 $\mu$ Sv	385.70 $\mu$ Sv	- $\mu$ Sv
04-09-2003	GL782	13:16 - 17:40	SFJ - CPH	OY-GRN	A-330-200	-	4:24	69:57	26.22 $\mu$ Sv	411.92 $\mu$ Sv	411.92 $\mu$ Sv	411.92 $\mu$ Sv	- $\mu$ Sv
06-09-2003	GLDK9307	05:32 - 05:58	CPH - MMX	OY-GRL	757-200	BBB	0:26	70:23	0.01 $\mu$ Sv	411.93 $\mu$ Sv	411.93 $\mu$ Sv	411.93 $\mu$ Sv	- $\mu$ Sv
06-09-2003	GLDK307	07:21 - 10:05	MMX - PMI	OY-GRL	757-200	BBB	2:44	73:07	11.90 $\mu$ Sv	423.83 $\mu$ Sv	423.83 $\mu$ Sv	423.83 $\mu$ Sv	- $\mu$ Sv
06-09-2003	GLDK308	11:42 - 14:12	PMI - MMX	OY-GRL	757-200	-	2:30	75:37	10.36 $\mu$ Sv	434.20 $\mu$ Sv	434.20 $\mu$ Sv	434.20 $\mu$ Sv	- $\mu$ Sv
06-09-2003	GLDK9308	14:52 - 15:12	MMX - CPH	OY-GRL	757-200	-	0:20	75:57	0.01 $\mu$ Sv	434.21 $\mu$ Sv	434.21 $\mu$ Sv	434.21 $\mu$ Sv	- $\mu$ Sv
02-10-2003	GL761	07:46 - 10:44	CPH - AEY	OY-GRL	757-200	GGG	2:58	78:55	16.74 $\mu$ Sv	450.95 $\mu$ Sv	450.95 $\mu$ Sv	450.95 $\mu$ Sv	- $\mu$ Sv
02-10-2003	GL762	11:38 - 14:20	AEY - CPH	OY-GRL	757-200	DDD	2:42	81:37	13.87 $\mu$ Sv	464.82 $\mu$ Sv	464.82 $\mu$ Sv	464.82 $\mu$ Sv	- $\mu$ Sv
17-10-2003	GL781	07:18 - 11:51	CPH - SFJ	OY-GRN	A-330-200	HHH	4:33	86:10	28.11 $\mu$ Sv	492.92 $\mu$ Sv	492.92 $\mu$ Sv	492.92 $\mu$ Sv	- $\mu$ Sv
17-10-2003	GL782	13:08 - 17:25	SFJ - CPH	OY-GRN	A-330-200	-	4:17	90:27	26.13 $\mu$ Sv	519.05 $\mu$ Sv	519.05 $\mu$ Sv	519.05 $\mu$ Sv	- $\mu$ Sv



**The Danish Solution**