



**Radiation Protection
on
Flying Airline Staff**

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Radiation Protection on Flying Airline Staff

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**European Council Directive 96/29/Euratom
of 13 May 1996**

laying down basic safety standards for the protection
of the health of workers and the general public
against the dangers arising from ionizing radiation

- Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with the directive before 13th May, 2000.
- Each member state may/shall require certain requirements but at least has to meet with the specified items of the directive.

- Germany

Radiation Protection Decree (Strahlenschutzverordnung)

RPD has become effective Juli 31st 2001.

A two year transitional period regarding airline staff is given.

Deadline: August 1st 2003

Radiation limits:

$0 \text{ mSv/a} < D < 1 \text{ mSv/a}$

non classified worker

$1 \text{ mSv/a} < D < 6 \text{ mSv/a}$

minor exposed worker

$6 \text{ mSv/a} < D < 20 \text{ mSv/a}$

exposed worker

max. annual dose:

20 mSv

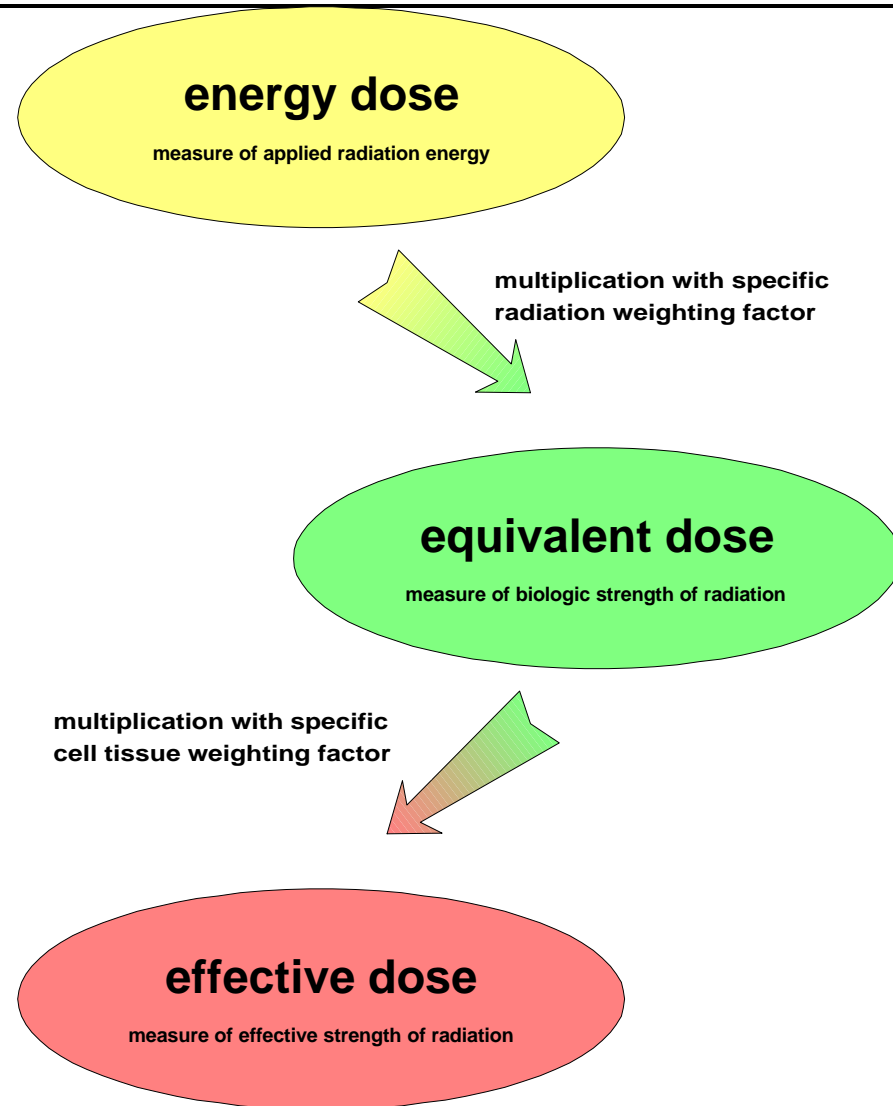
live time dose limit:

400 mSv

Energy Dose can be measured directly.

Equivalent Dose can be measured with calibrated equipment or has to be calculated.

Effective Dose has to be calculated.



Regulations:

- A record containing the results of monitoring shall be made for each single exposed worker.
- The monitoring results shall be available not later than 6 month after an exposure occurred.
- The records shall retained until the individual has or would have attained the age of 75 years, but in any case not less than 30 years from the termination of work.
- The records shall erased not later the individual has or would have attained the age of 95 years.

Regulations:

Each employer shall take appropriate measures, in particular:

- to assess the exposure of the crew concerned.
- to take into account the assessed exposure when organizing working schedules with a view to reducing the doses of highly exposed aircrew.

=> ALARA philosophy (as low as reasonably achievable)

Regulations:

Special protection during pregnancy

As soon as a pregnant woman informs the undertaking of her condition, the protection of the child to be born shall be comparable with that provided for members of the public.

=> effective dose while pregnancy < 1 mSv

Regulations:

Each undertaking shall inform exposed workers at least once a year,

- on the health risks involved in their work
- the importance of complying with technical, medical and administrative requirements

Regulations:

The undertaking shall note the date and contents of information. Each single worker shall confirm the information by signature.

The notes shall retained over a time period of five years.

Regulations:

Each undertaking shall transmit at least every six month the results of dose monitoring to GAA (LBA) involved following information:

- name, address and function of each employee
- accumulated monthly doses

Each employee has to be registered through GAA with an individual identification number.

Regulations:

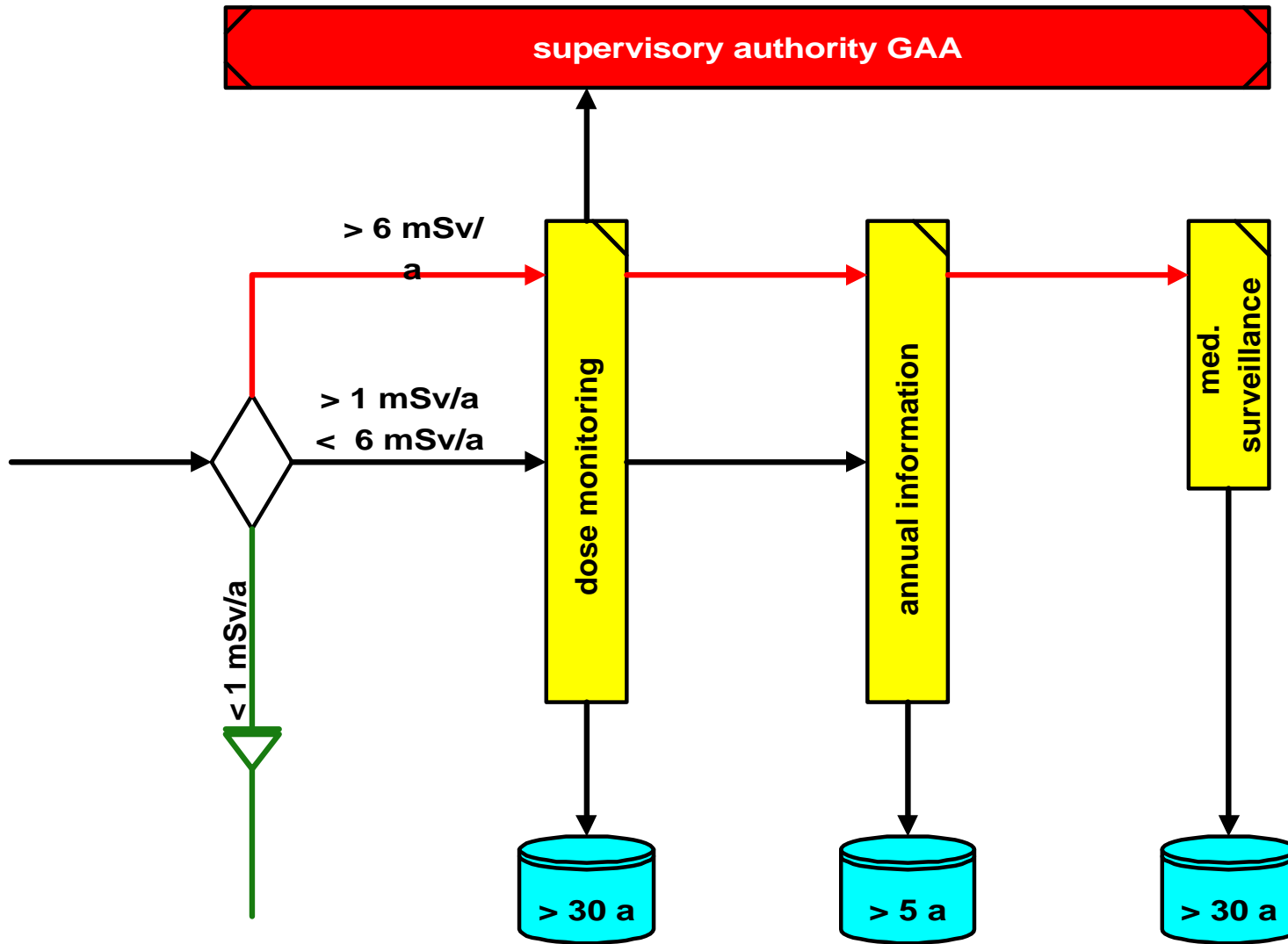
A medical surveillance is required prior exceeding a dose of 6 mSv/a.

The proper healthy condition of worker has to be testified. (=> grounding order)

The medical surveillance shall be the responsibility of approved medical practitioners or approved occupational health services.

Regulations:

- A record containing the results of the medical examination shall be made.
- The records shall retained until the individual has or would have attained the age of 75 years, but in any case not less than 30 years from the termination of work.
- The records shall erased not later the individual has or would have attained the age of 95 years



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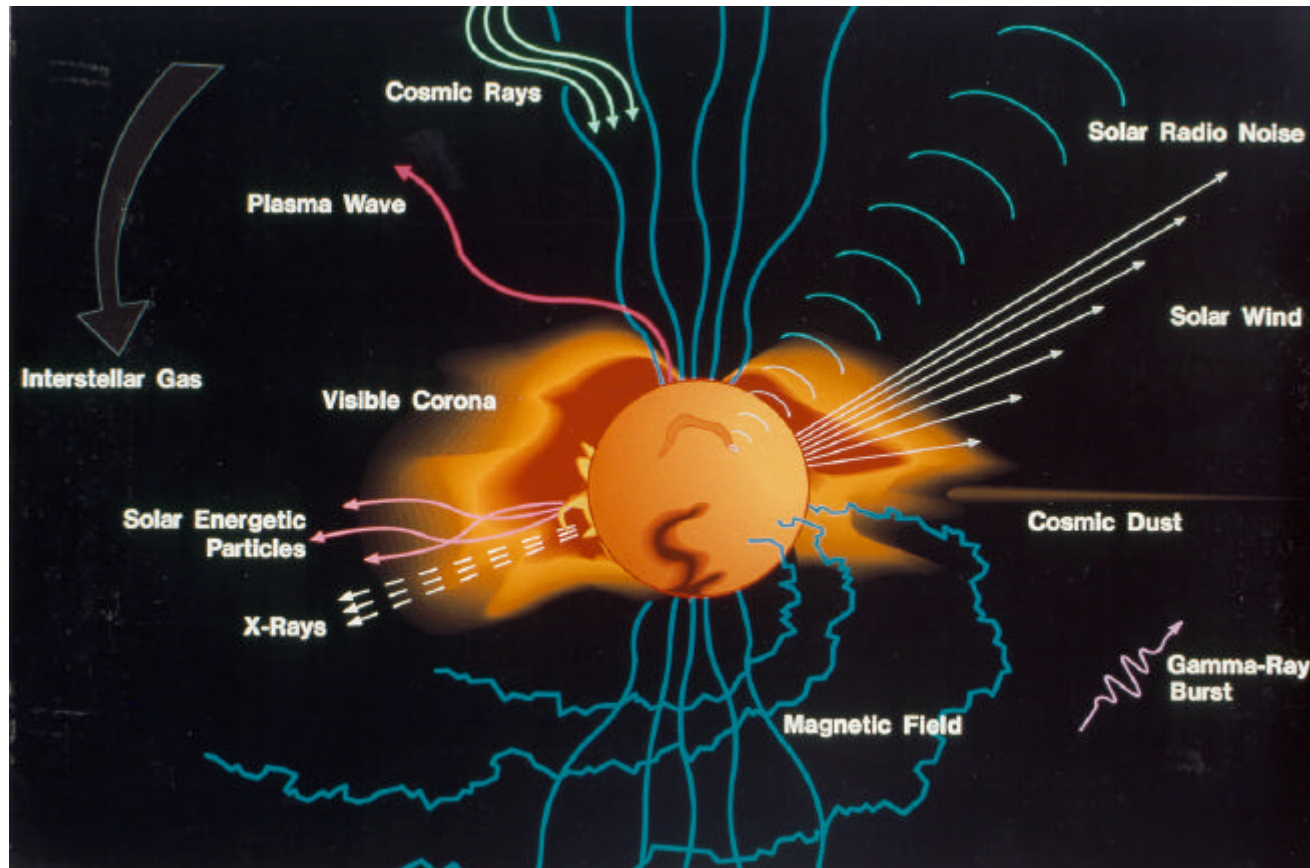
Outlook

Cosmic Radiation

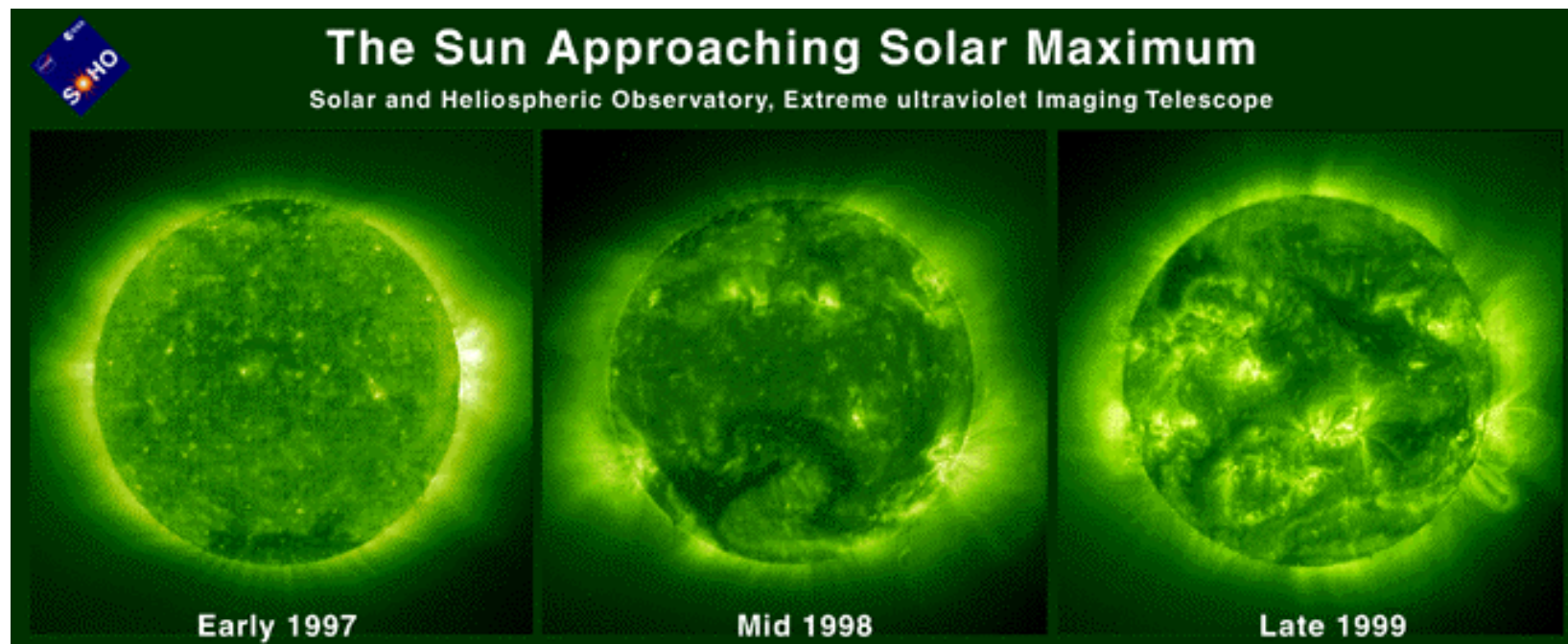
The Galaxies are emitters of high energy charged particles



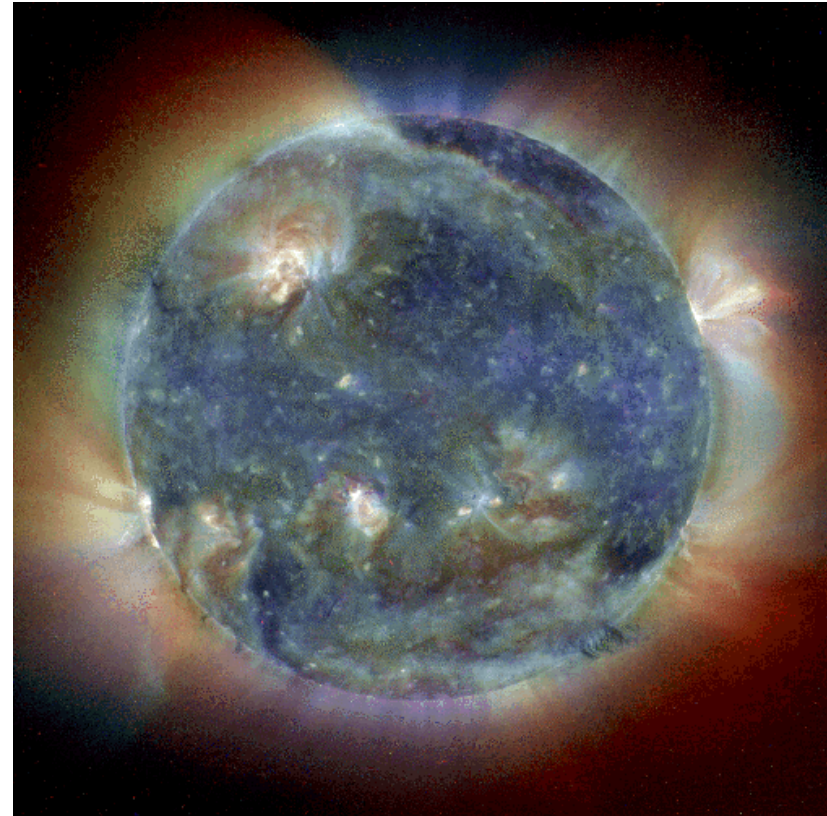
Solar Emmissions



Temporal Variations of Solar Activity

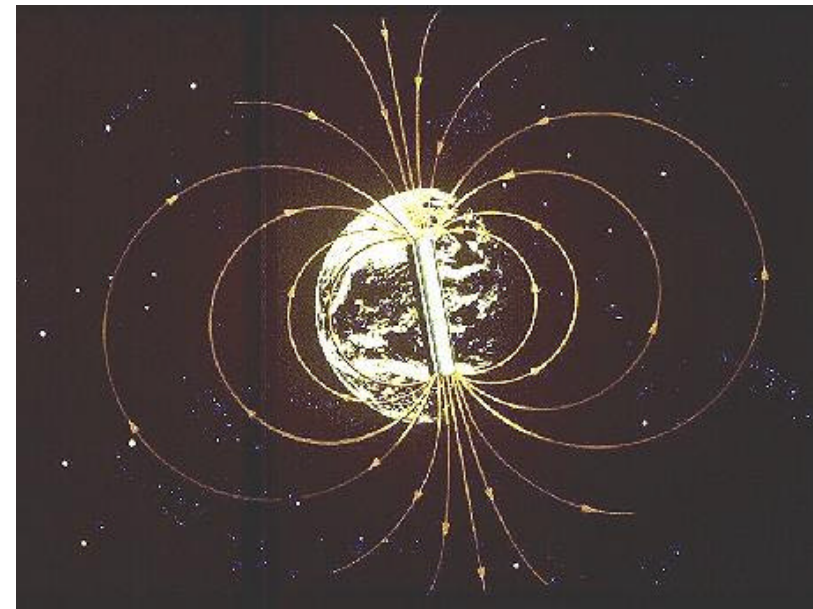


- A high number of sunspots is connected with increased solar activity :
- The intensity of the solar wind raises.
- The number of short-term solar energy eruption increases.
=> solar flares



The Magnetic Shield

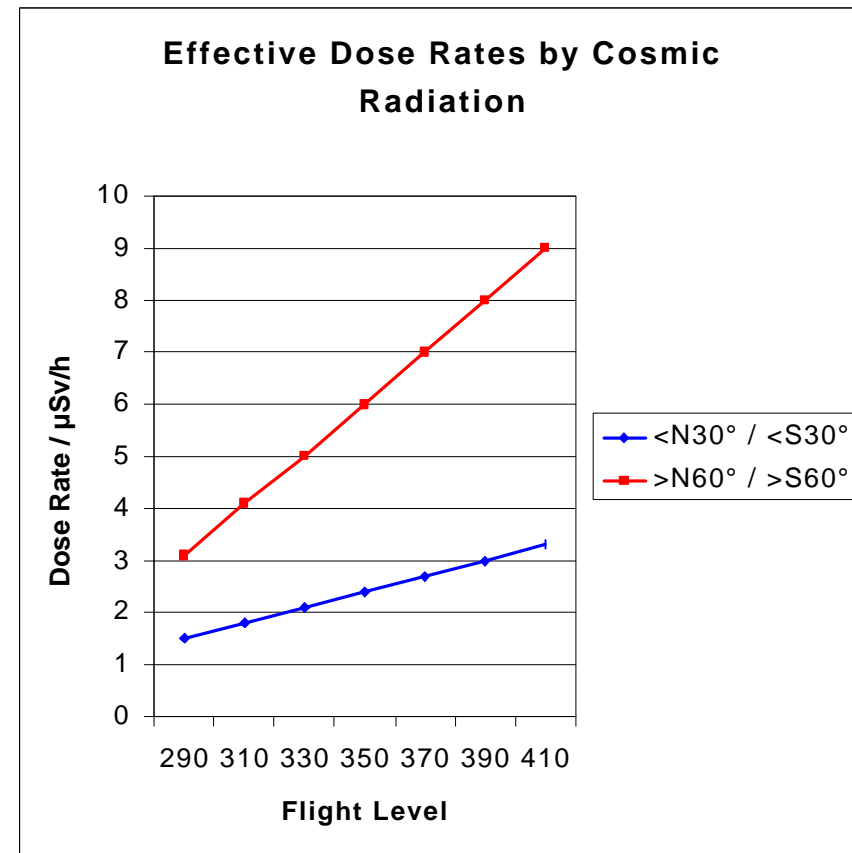
- At the equatorial region on earth (-30° to $+30^\circ$) the magnetical field lines are in parallel to earth's axis
 \Leftrightarrow shielding.
- At polar areas ($> \pm 60^\circ$) the magnetical field lines mouth into atmosphere
 \Leftrightarrow reinforced penetration.



Flights at **equatorial regions** will result in lower doses.

Flights at **polar regions** will result in higher doses.

Solar Activity affects the strength of radiation.



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Dose Estimation:

Due to physical and mathematical described processes within the atmosphere dose estimation programs can be utilized.

Airlines has to provide necessary flight and employment data to generate proper dose monitoring.

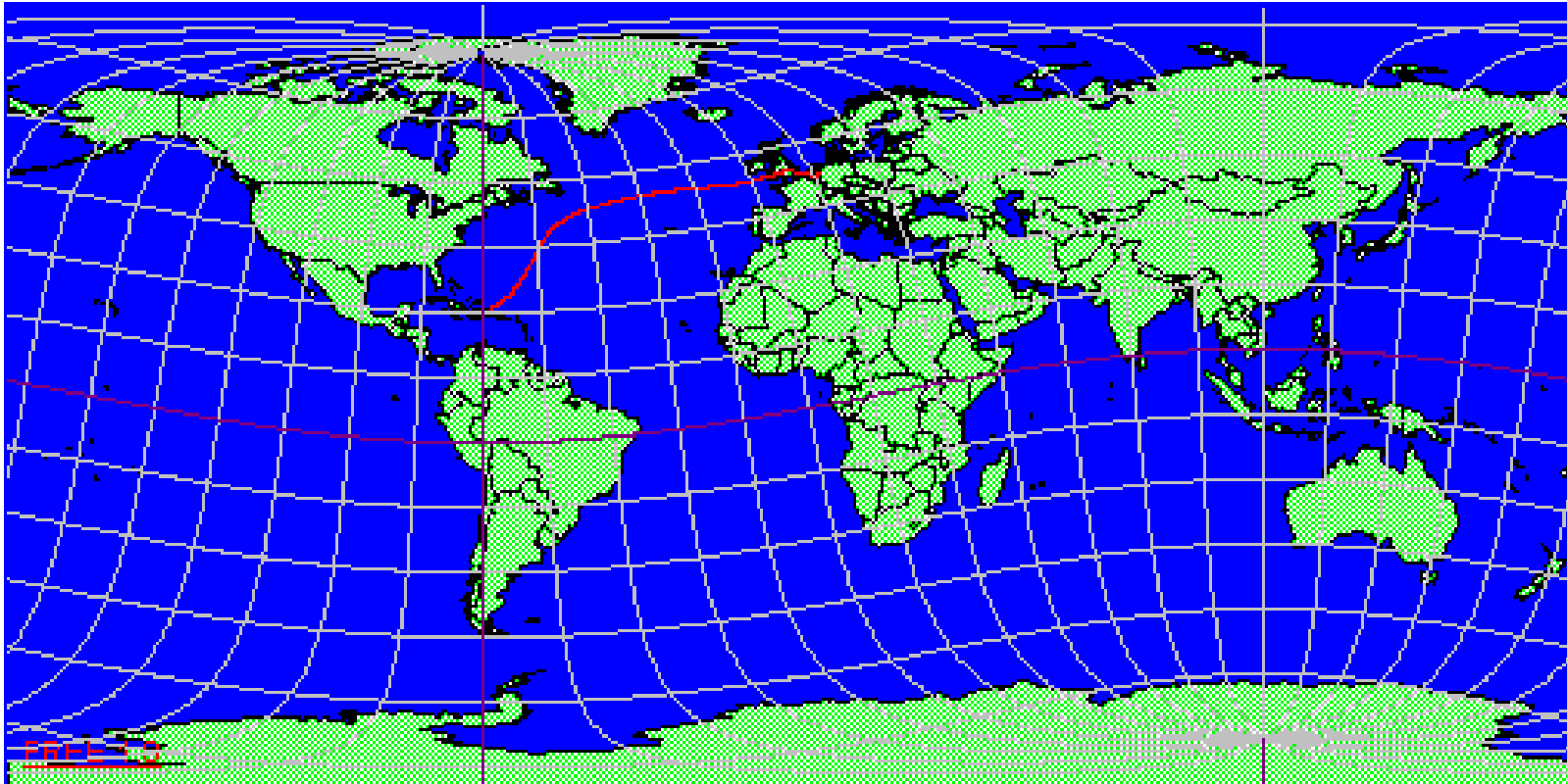
Dose Estimation:

Necessary flight data are:

- date of flight
- departure and arrival airport
- ascend and descend times
- waypoints with FL and elapsed time

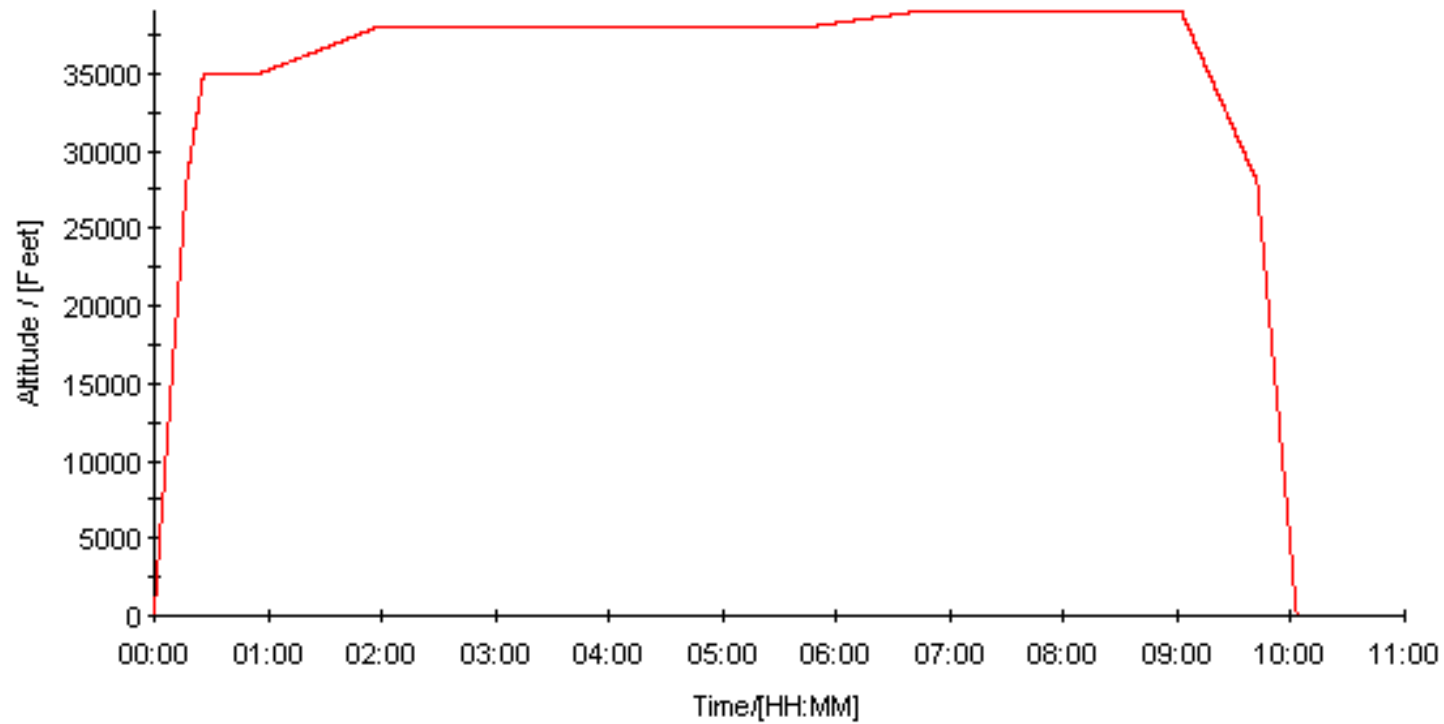
Dose Estimation:

DUS -> POP

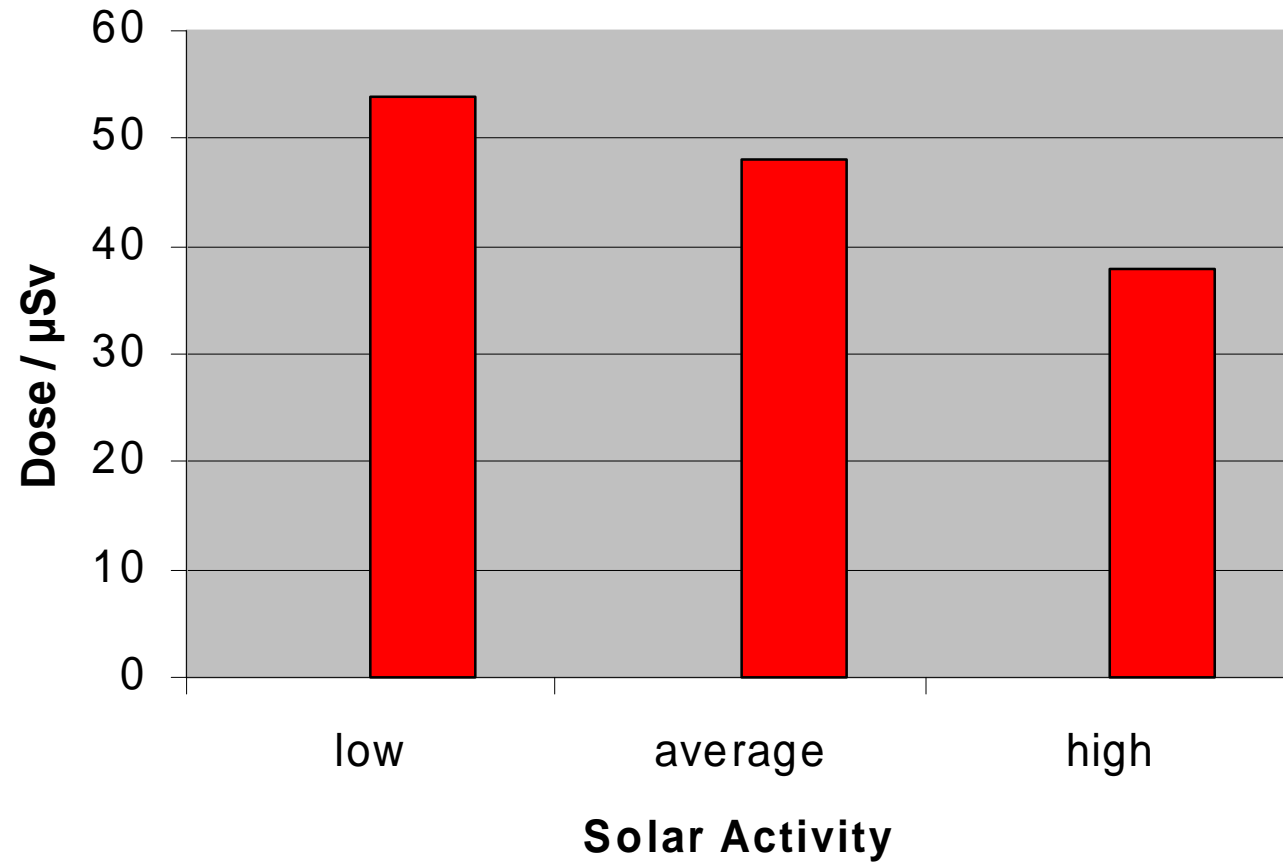


Dose Estimation:

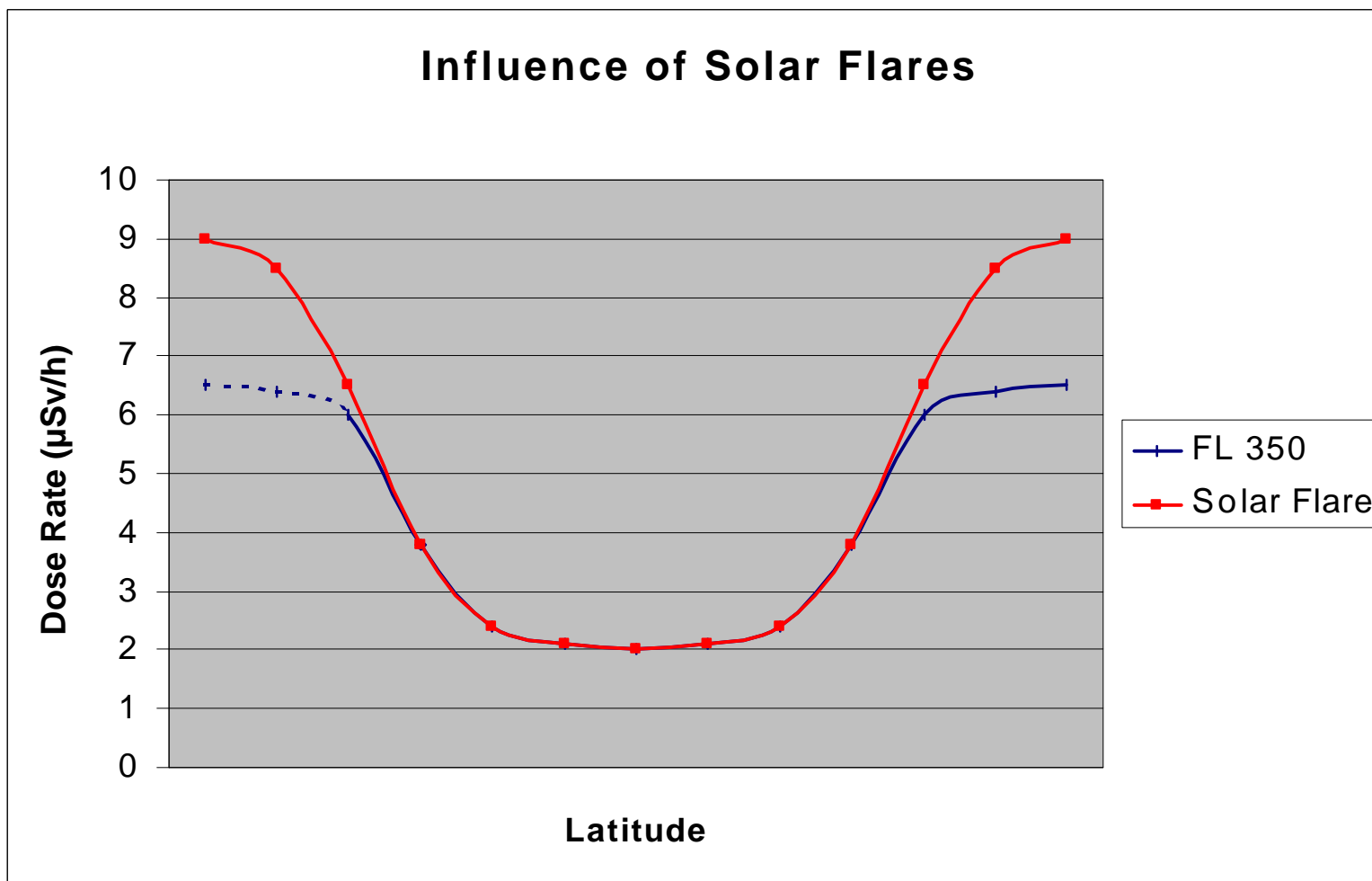
DUS -> POP



Dose Estimation:



Dose Estimation:



Dose Estimation:

- Solar Flares or Solar Particle Events occurs usually in a tight schedule.
- SPE higher dose rates significantly in polar regions (> 60° latitude).
- The strength of a SPE is not predictable.
- A dose estimation program shall match SPE.

Dose Estimation:

Shown results based on PCAIRE®
(onliest software in commercial use worldwide today)

Supplementary informations: www.PCAIRE.com

Trial license to be applied : PCAIREGermany@aol.com

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Expectations:

- Flying airline staff is expected to be exposed with an annually average of ~ 3,5 mSv/a.
- continental operating staff: ~ 3 mSv/a.
- Predominate intercontinental staff: ~ 4,5 mSv/a

- Spread due to solar activity $\pm 15 \%$
- Unlikely exceeding 6mSv/a level (based on today's aircraft)