Radiation Protection Activities for Aircrew in Korea

Jaejin Lee, Junga Hwang, Kyung-Suk Cho, Hiroshi Yasuda* andYoung-Deuk Park
Korea Astronomy and Space Science, Korea
*National Institute of Radiological Sciences, Japan

Cross-Polar Routes

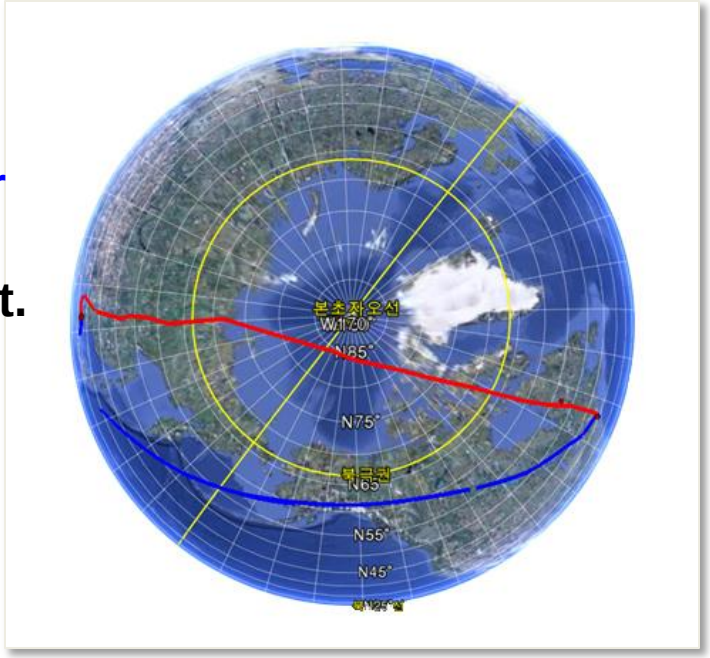
More than 13 airlines have operated the cross-polar routes since 1999.

Why airline companies want to fly over polar region?

Cross-polar routes save time, fuel and cost.
About 30 min faster than non-polar routes.

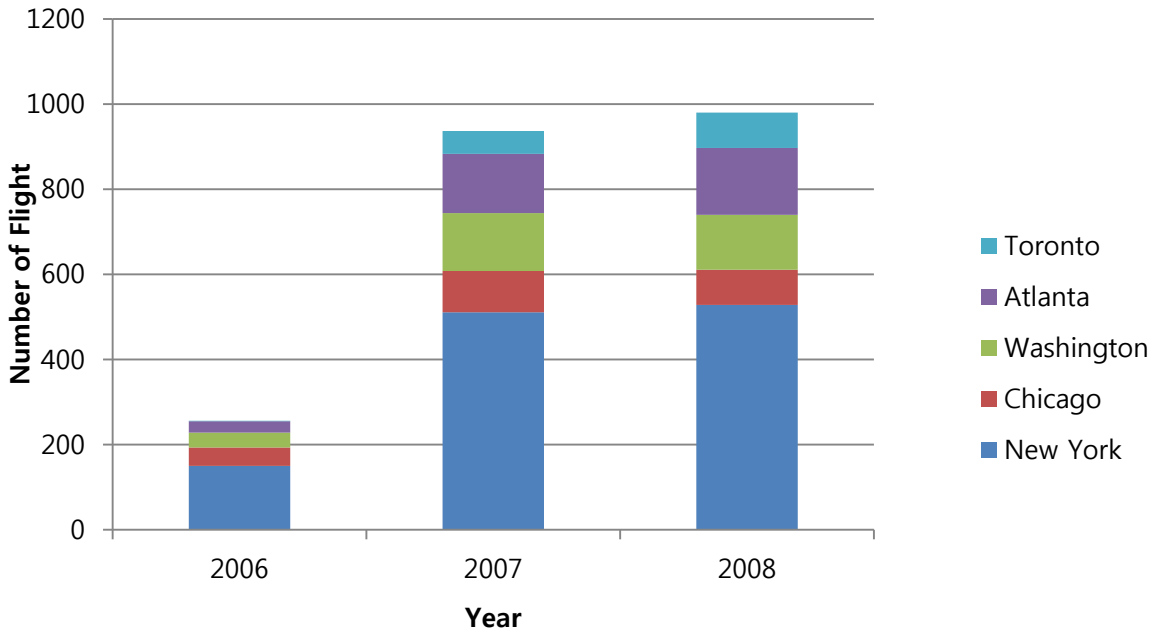
An airline can save US$ 5M a year.

However, there are some concerns
- **Radiation increase**
- **Communication**
- **Cold weather**
- **Navigation error**



Flight of Incheon-Washington DC

Polar Route operation of Korean Airlines

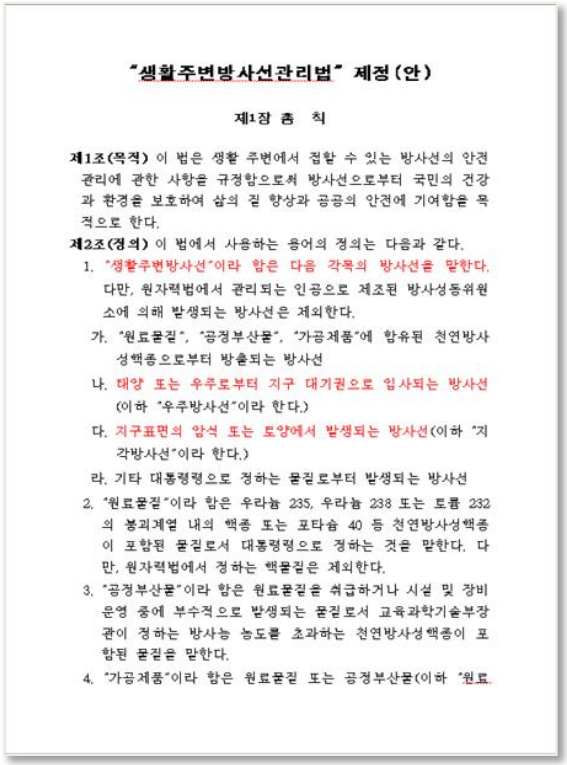


- Korean Air(KAL) has operated flight on cross-polar route since 2006.
- Asiana Airlines have operated flight on cross-polar route since 2009.
- More than 600,000 passengers used the polar routes

Public Issue: Radiation on polar route

Radiation on polar route was issued by TV program in Korea.

Legislation in Korea



"생활주변방사선관리법" 제정(안)

제1장 총 칙

제1조(목적) 이 법은 생활 주변에서 접할 수 있는 방사선의 안전 관리에 관한 사항을 규정함으로써 방사선으로부터 국민의 건강과 환경을 보호하여 삶의 질 향상과 공공의 안전에 기여함을 목적으로 한다.

제2조(정의) 이 법에서 사용하는 용어의 정의는 다음과 같다.

1. "생활주변방사선"이라 함은 다음 각목의 방사선을 말한다. 다만, 원자력법에서 관리되는 인공으로 제조된 방사성동위원소에 의해 발생되는 방사선은 제외한다.
   가. "원료물질", "공정부산물", "가공제품"에 함유된 천연방사성핵종으로부터 방출되는 방사선
   나. 태양 또는 우주로부터 지구 대기권으로 입사되는 방사선(이하 "우주방사선"이라 한다.)
   다. 지구표면의 암석 또는 토양에서 발생되는 방사선(이하 "지각방사선"이라 한다.)
   라. 기타 대통령령으로 정하는 물질로부터 발생되는 방사선
2. "원료물질"이라 함은 우라늄 235, 우라늄 238 또는 토륨 232의 붕괴계열 내의 핵종 또는 포타슘 40 등 천연방사성핵종이 포함된 물질로서 대통령령으로 정하는 것을 말한다. 다만, 원자력법에서 정하는 핵물질은 제외한다.
3. "공정부산물"이라 함은 원료물질을 취급하거나 시설 및 장비 운영 중에 부수적으로 발생되는 물질로서 교육과학기술부장관이 정하는 방사능 농도를 초과하는 천연방사성핵종이 포함된 물질을 말한다.
4. "가공제품"이라 함은 원료물질 또는 공정부산물(이하 "원료

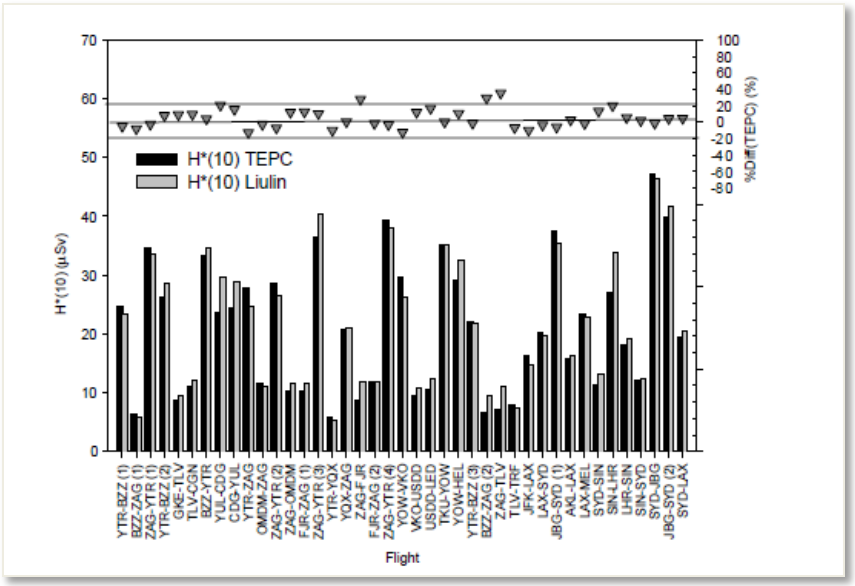
Living Environment Radiation Control Law which is currently pending on the National Assembly

Definition of Cosmic Radiation
- Radiation from Sun and Deep Space to Earth atmosphere

By this law,
Airline companies should monitor and record radiation dose of crews.
Korean government should provide guidelines to protect crews and passengers from cosmic radiation.

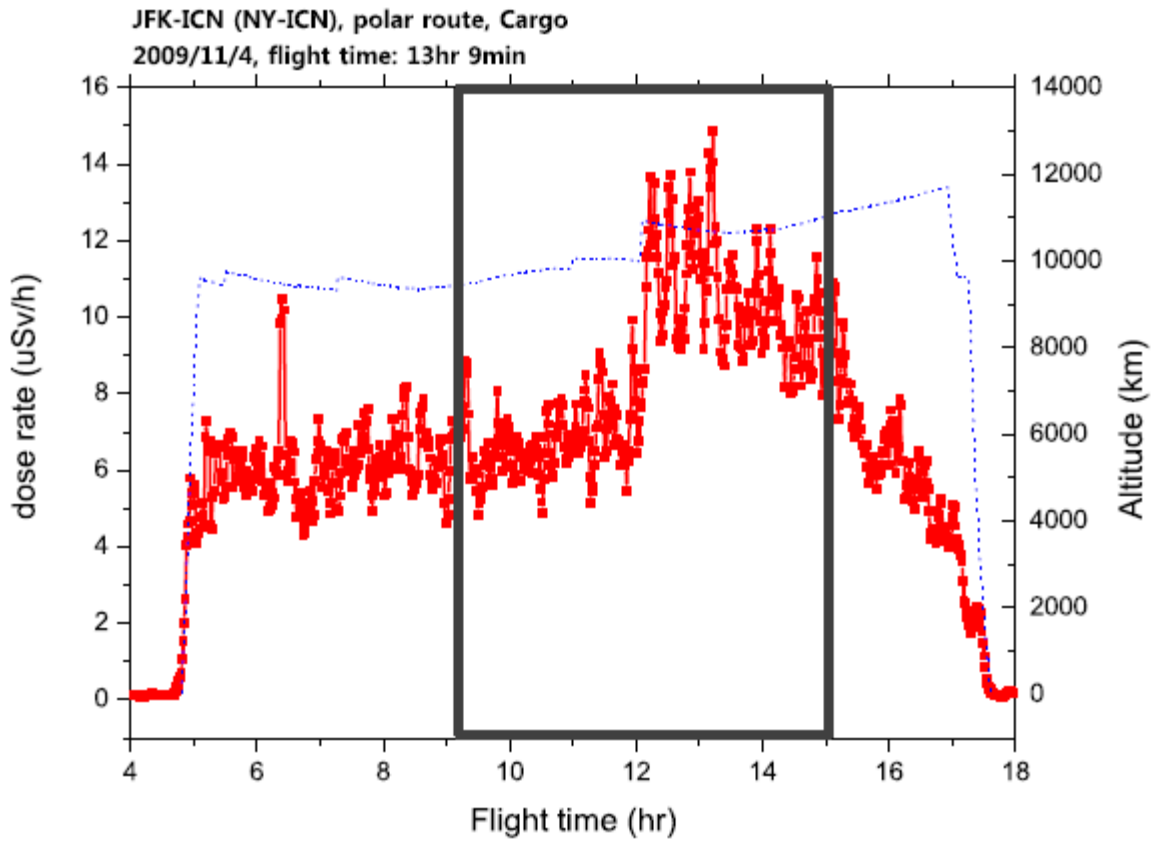
Measurement of Radiation

Size: 110 x 100 x 45 mm
Detector: Solid State Detector
Mass: 0.75 kg
Dose Range: 0.93 μSv ~ 156 mSv



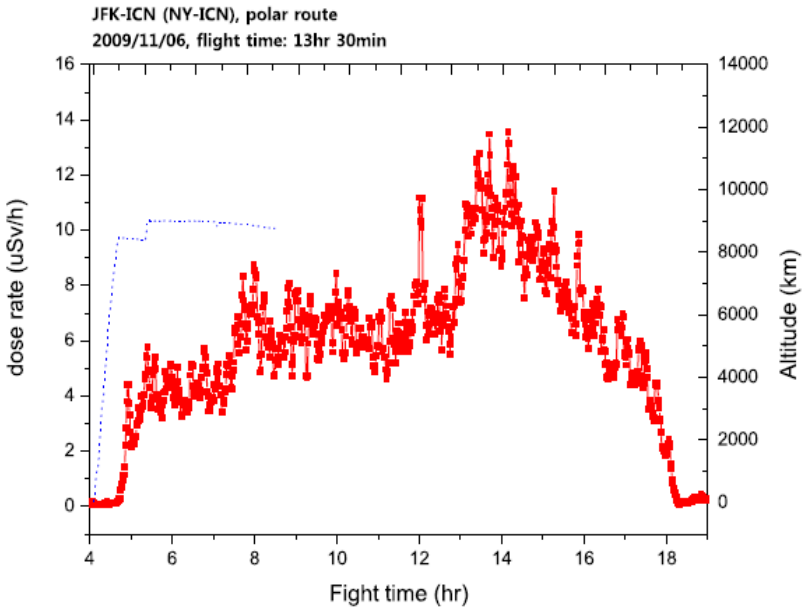
– Comparison of Liulin and TEPC –

Radiation on the cross-polar routes

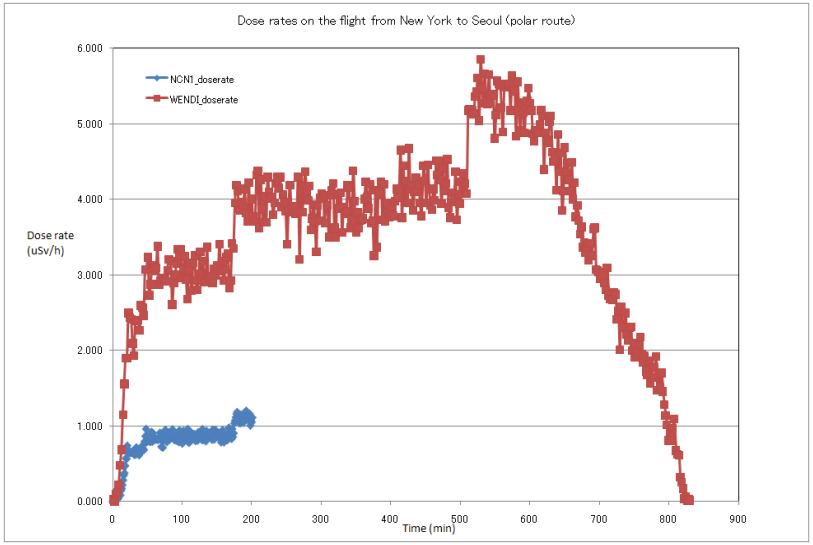


Total Dose : 91.84 uSv

Measurement with different instrument



Liulin measurement



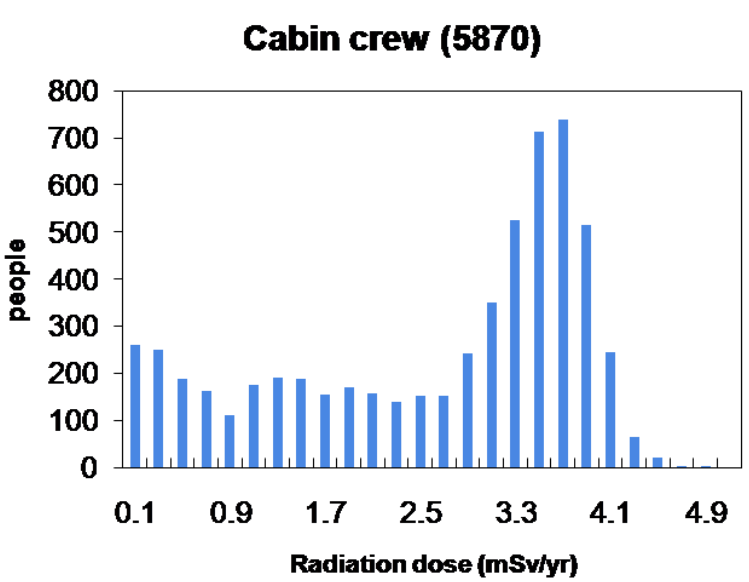
Neutron Detector
(NCN1, WENDI)

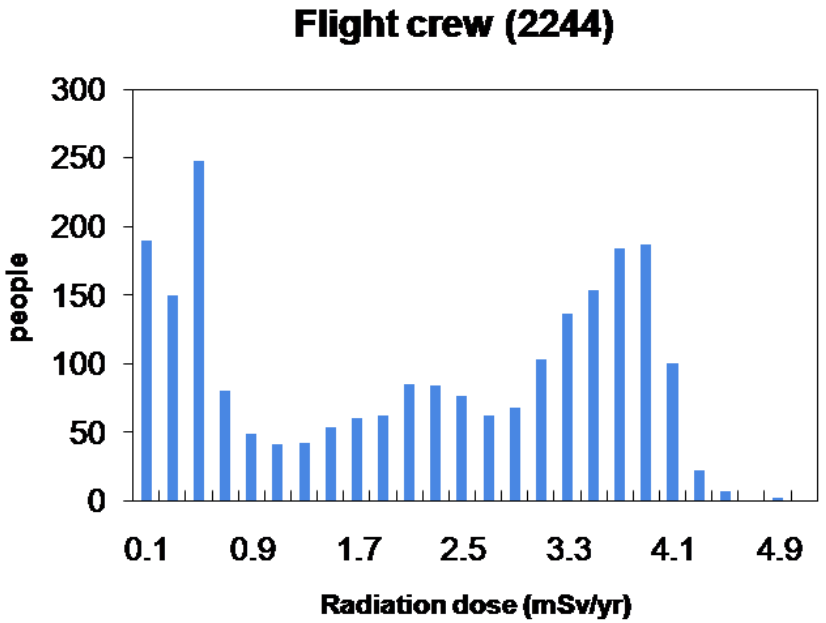
There are no perfect instrument for measuring dose at aircraft altitude.

Radiation on the cross-polar routes

Date	Polar route (NY-ICN)	North pacific route (ICN-NY)
Oct 5	76.07 (uSv)	65.85 (uSv)
Nov 2	91.84 (uSv)	65.83 (uSv)
Nov5	86.48 (uSv)	88.78 (uSv)
Average	84.7 (uSv)	73.48 (uSv)
CARI-6M	84.9 (uSv)	64.3 (uSv)

Annual Radiation dose of Korean Air Crew





Calculated by CARI-6M with 2008 heliocentric potential

Annual radiation dose comparison

		JISCARD	CARI-6	EPCARD	PCAIRE
Flight Crew (A300, B777)	Solar Max	0.15 ~ 1.98	0.24 ~ 2.83	0.20 ~ 3.16	0.24 ~ 2.55
	Solar Min	0.17 ~ 2.93	0.27 ~ 3.86	0.29 ~ **4.14**	0.33 ~ 3.6
Cabin Crew	Solar Max	1.85 ~ 2.56	2.81 ~ 3.76	2.88 ~ 3.72	2.75 ~ 3.82
	Solar Min	2.59 ~ 3.70	3.71 ~ 5.15	4.14 ~ 5.49	3.93 ~ **5.54**

Report for Korean Government

1. Guideline on the annual dose of 6 mSv for aircrew.
   (Pregnant women should be exposed less than 1 mSv)

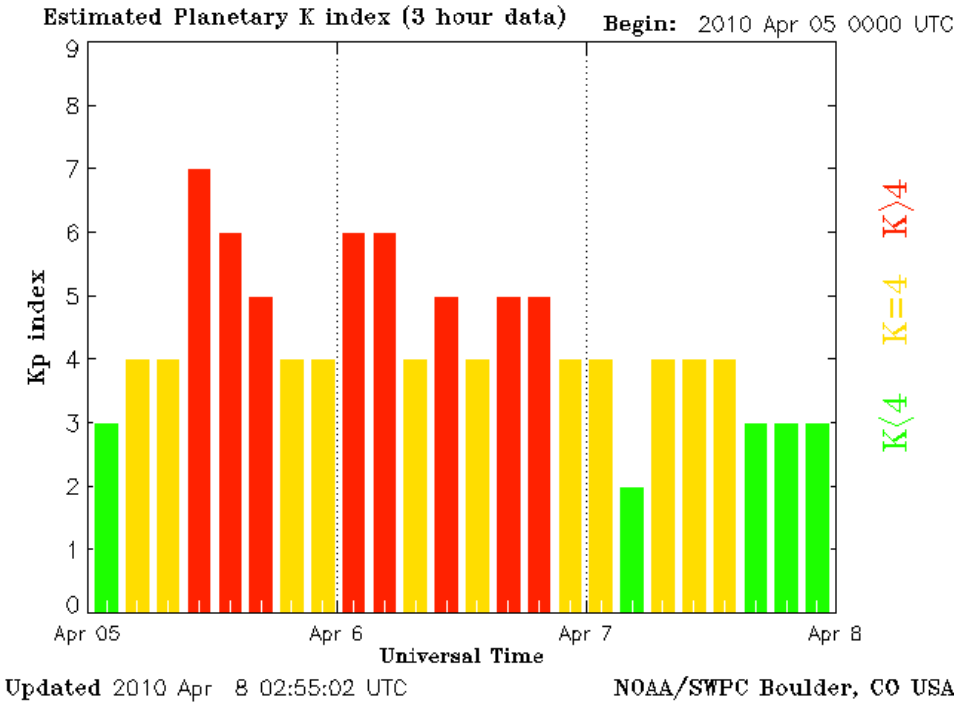
2. Dose control and management with model

3. Considering space weather effect in estimating radiation dose

4. Education for crew

5. Continuous measurement and improve dose calculation program

Space Weather on Polar Route



Do you think airline companies could operate cross-polar routes at this time ?

Conclusion

Still we don't fully understand what happen on the cross-polar route during severe space storm.

We need to do continuous measurement of radiation and improve dose calculation program.

International collaboration is required for

- **Standard of Radiation measurement at the altitude of aircraft**
- **Standard of assessment of radiation dose of aircrew**

Thank You