

# **JISCARD EX Personal Edition**

## **User's Manual**

### **ver.1.0**

[http://www.nirs.go.jp/research/jiscard/ex/index\\_ex\\_e.html](http://www.nirs.go.jp/research/jiscard/ex/index_ex_e.html)

Hiroshi Yasuda

National Institute of Radiological Sciences



October 20th, 2008

The names of companies, commercial products or services referred in this document are generally trademarks or trade names of manufacturers.

© 2008 Hiroshi Yasuda / National Institute of Radiological Sciences

# Index

- 1. Notices for Use..... 3
- 2. How to Use the Program..... 4
  - 2-1. When flight path is known ..... 6
  - 2-2. When flight path is unknown ..... 9
- 3. Program Description..... 15
  - 3-1. Outline of the program ..... 15
  - 3-2. Comparison with Other Programs..... 17
- Acknowledgements ..... 19
- References ..... 19

## 1. Notices for Use

The program “JISCARD EX Personal Edition” is developed by National Institute of Radiological Sciences (NIRS). Any materials (codes, databases, figures and documents) of this program belong to the manufacturer (NIRS and the author of this document) and protected by national copyright laws.

Copies of the program may be made for personal use as allowed by the copyright laws. Permission of the manufacturer is required for all other use, including multiple or systematic copying, copying for advertising or promotional purposes, etc. If you need permissions, you can send an e-mail to the manufacturer ([airdose@nirs.go.jp](mailto:airdose@nirs.go.jp)).

Results obtained using this program may be published or distributed externally, as long as you refer to this guide in the following style:

**1) Hiroshi Yasuda: JISCARD EX Personal Edition User’s Manual (ver.1.0), 2008,  
[http://www.nirs.go.jp/research/jiscard/ex/manual\\_e.pdf](http://www.nirs.go.jp/research/jiscard/ex/manual_e.pdf)**

The program should be considered as a personal tool, and not used for administrative purposes. The calculation algorithms, data, or parameters may have some errors that we have not yet identified. No responsibility is assumed by the manufacturer for any injury and/or damage to persons or property from any use or operation of the program or data contained in this work.

The program is carefully tested with Microsoft Excel 2003 and Internet Explorer 7 on Windows XP, and confirmed to be safe for normal operation of other software, operating system and PC. However, there could be errors in user with other software, PCs, and/or printers. It is impossible to test the program on the full spectrum of those combinations.

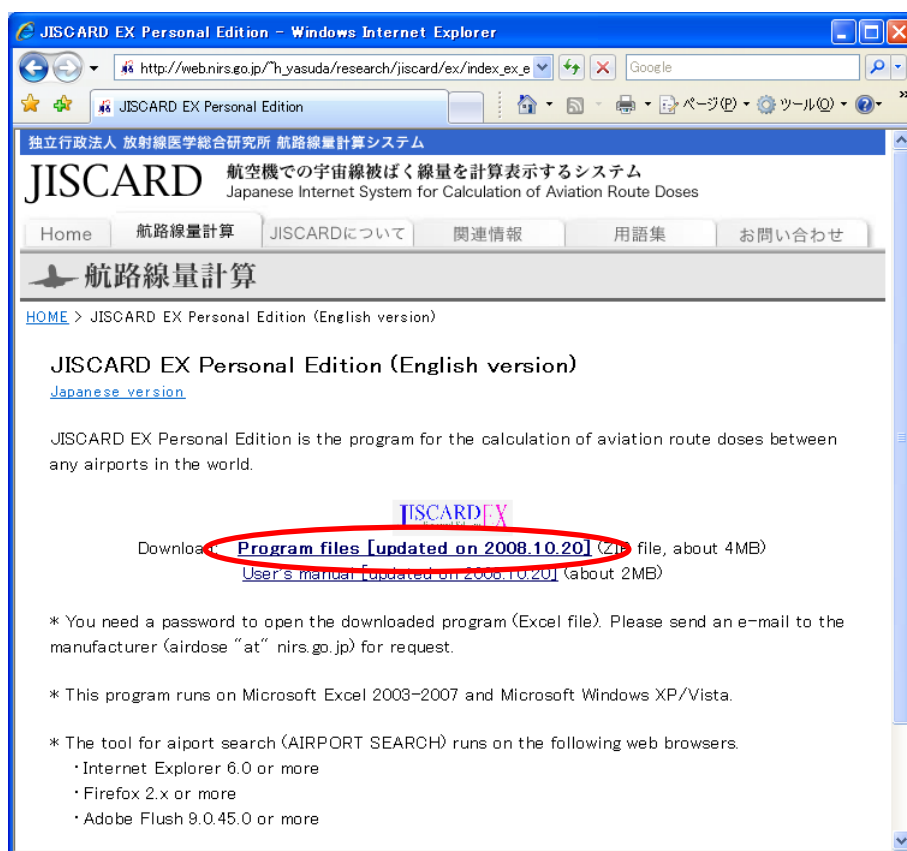
The program may be changed for further improvement without notice. As results, some part of figures and instructions in this document may be different from reality.

## 2. How to Use the Program

First, access the web page for downloading the program:

**[http://www.nirs.go.jp/research/jiscard/ex/index\\_ex\\_e.html](http://www.nirs.go.jp/research/jiscard/ex/index_ex_e.html)**

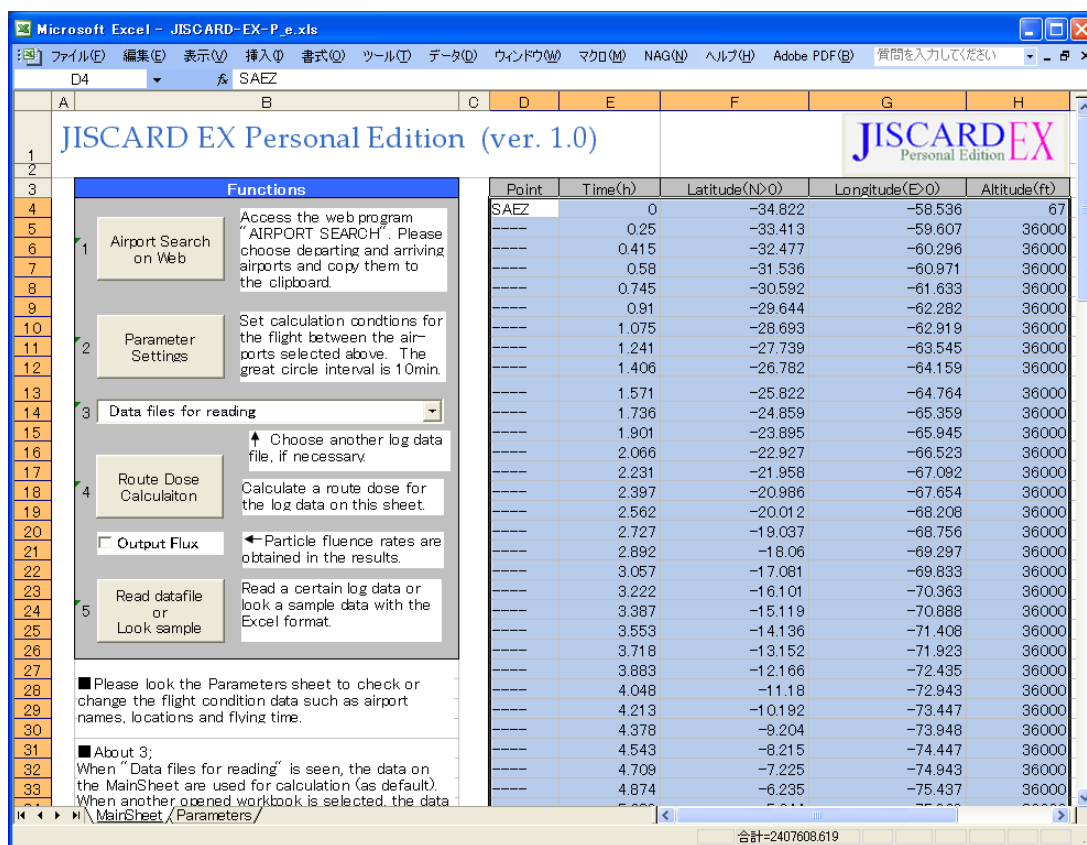
Next, click “Program files” and download the archive program (ZIP file) to your PC.



Extract the ZIP file and then open an Excel file “JISCARD-EX-P\_e.xls”. As to macro setting, make the macro function effective. In advance, you need set the macro security level of Microsoft Excel as “Medium”.

Next, input the password to a box. For the first time or if you forgot the password, please send an e-mail to the manufacturer (airdose@nirs.go.jp) with the subject of “password request”.

Soon after password input, the “MainSheet” (below) appears on the display.



## 2-1. When flight path is known

Input a log data of flight path (time from departure, latitude, longitude and altitude) to the mainsheet cells. Also, input other information on airport locations, departing time and cruising time to another “Parameter” sheet. The information on airports can be obtained using a web tool “AIRPORT SEARCH” as explained in the next chapter.

The screenshot shows a Microsoft Excel spreadsheet titled "JISCARD-EX-P.e.xls". The spreadsheet is divided into several sections. At the top, there is a note: "\* This worksheet shows flight information relating to the log data on the MainSheet. The information on departure/arrival airports can be taken from the web program 'AIRPORT SEARCH'." Below this, there is a table with columns: Country, Airport, Code, Latitude, Longitude, Altitude(ft), and Mileage. The data rows show a flight from Argentina (Ministro Pistarini International Airport, SAEZ EZE) to the U.S.A. (Dallas Fort Worth International Airport, KDFW DFW). The flight details include: Departure time (2008/10/18 13:34), Ascending time (15 min), Descending time (20 min), Onboard time (11:29), and Cruising altitude (36000 feet). The Time Interval for great circle route (min) is 0. Below the table, there is a section titled "Functions" with two sub-sections: "Airport Search on Web" and "Parameter Settings". The "Airport Search on Web" section contains a text box with instructions: "Access the web program 'AIRPORT SEARCH'. Please choose departing and arriving airports and copy them to the clipboard." The "Parameter Settings" section contains a text box with instructions: "Set calculation conditions for the flight between the airports selected above. The great circle interval is 10min." The "Username" field is set to "Parma Jiscard".

	A	B	C	D	E	F	G	H
1	* This worksheet shows flight information relating to the log data on the MainSheet. The information on departure/arrival airports can be taken from the web program "AIRPORT SEARCH".							
2		Country	Airport	Code	Latitude	Longitude	Altitude(ft)	Mileage
3	Departure	Argentina	Ministro Pistarini Internacio	SAEZ EZE	-34.8222	-58.5358	67	531.7
4	Arrival	U.S.A.	Dallas Fort Worth Internatio	KDFW DFW	32.8964	-97.0375	603	
5								
6	Departure time (yyyy/MM/dd hh:mm)	2008/10/18 13:34						
7	Ascending time (min)	15						
8	Descending time (min)	20						
9	Onboard time (hh:mm)	11:29						
10	Cruising altitude (feet)	36000						
11								
12	Time Interval for great circle route (min)	0						
13	The "0" means no interpolation.							
14								
15	<b>Functions</b>		<b>Username</b>					
16			Parma Jiscard					
17								
18	①	Airport Search on Web	Access the web program "AIRPORT SEARCH". Please choose departing and arriving airports and copy them to the clipboard.					
19								
20								
21								
22								
23	②	Parameter Settings	Set calculation conditions for the flight between the airports selected above. The great circle interval is 10min.					
24								
25								
26								

Completing data input, then push the “Route Dose Calculation” button in the left panel of the mainsheet.

**JISCARD EX Personal Edition (ver. 1.0)**

**Functions**

- 1 Airport Search on Web: Access the web program "AIRPORT SEARCH". Please choose departing and arriving airports and copy them to the clipboard.
- 2 Parameter Settings: Set calculation conditions for the flight between the airports selected above. The great circle interval is 10min.
- 3 Data files for reading: Choose another log data file, if necessary.
- 4 **Route Dose Calculation**: Calculate a route dose for the log data on this sheet.
  - ☐ Output Flux: Particle fluence rates are obtained in the results.
- 5 Read datafile or Look sample: Read a certain log data or look a sample data with the Excel format.

■ Please look the Parameters sheet to check or change the flight condition data such as airport names, locations and flying time.

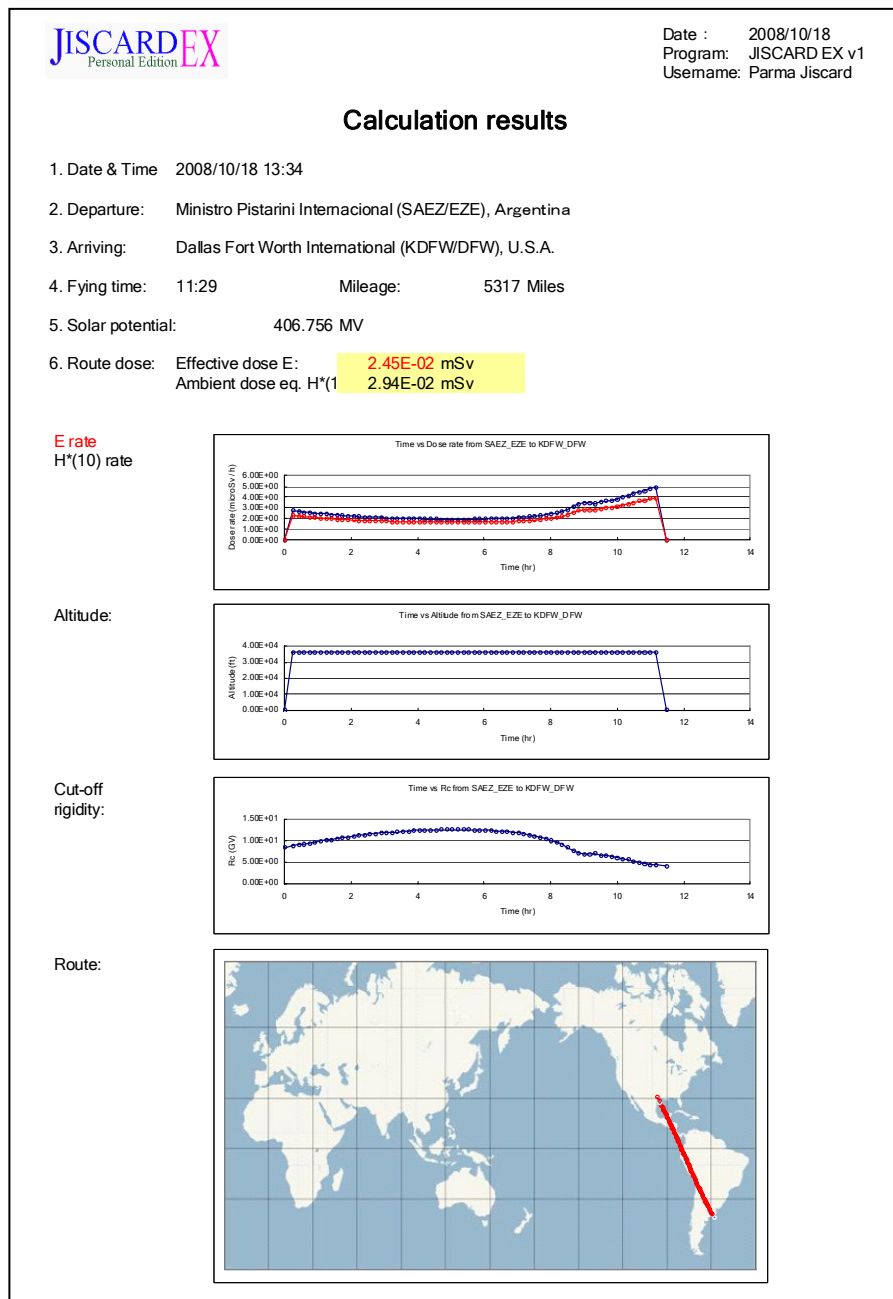
■ About 3;  
When "Data files for reading" is seen, the data on the MainSheet are used for calculation (as default).  
When another opened workbook is selected, the data

Point	Time (hr)	Latitude (°N)	Longitude (°E)	Altitude (ft)
SAEZ	0	-34.822	-58.536	67
----	0.25	-33.413	-59.607	36000
----	0.415	-32.477	-60.296	36000
----	0.58	-31.536	-60.971	36000
----	0.745	-30.592	-61.633	36000
----	0.91	-29.644	-62.282	36000
----	1.075	-28.693	-62.919	36000
----	1.241	-27.739	-63.545	36000
----	1.406	-26.782	-64.159	36000
----	1.571	-25.822	-64.764	36000
----	1.736	-24.859	-65.359	36000
----	1.901	-23.895	-65.945	36000
----	2.066	-22.927	-66.523	36000
----	2.231	-21.958	-67.092	36000
----	2.397	-20.986	-67.654	36000
----	2.562	-20.012	-68.208	36000
----	2.727	-19.037	-68.756	36000
----	2.892	-18.06	-69.297	36000
----	3.057	-17.081	-69.833	36000
----	3.222	-16.101	-70.363	36000
----	3.387	-15.119	-70.888	36000
----	3.553	-14.136	-71.408	36000
----	3.718	-13.152	-71.923	36000
----	3.883	-12.166	-72.435	36000
----	4.048	-11.18	-72.943	36000
----	4.213	-10.192	-73.447	36000
----	4.378	-9.204	-73.948	36000
----	4.543	-8.215	-74.447	36000
----	4.709	-7.225	-74.943	36000
----	4.874	-6.235	-75.437	36000

合計=2407608.619

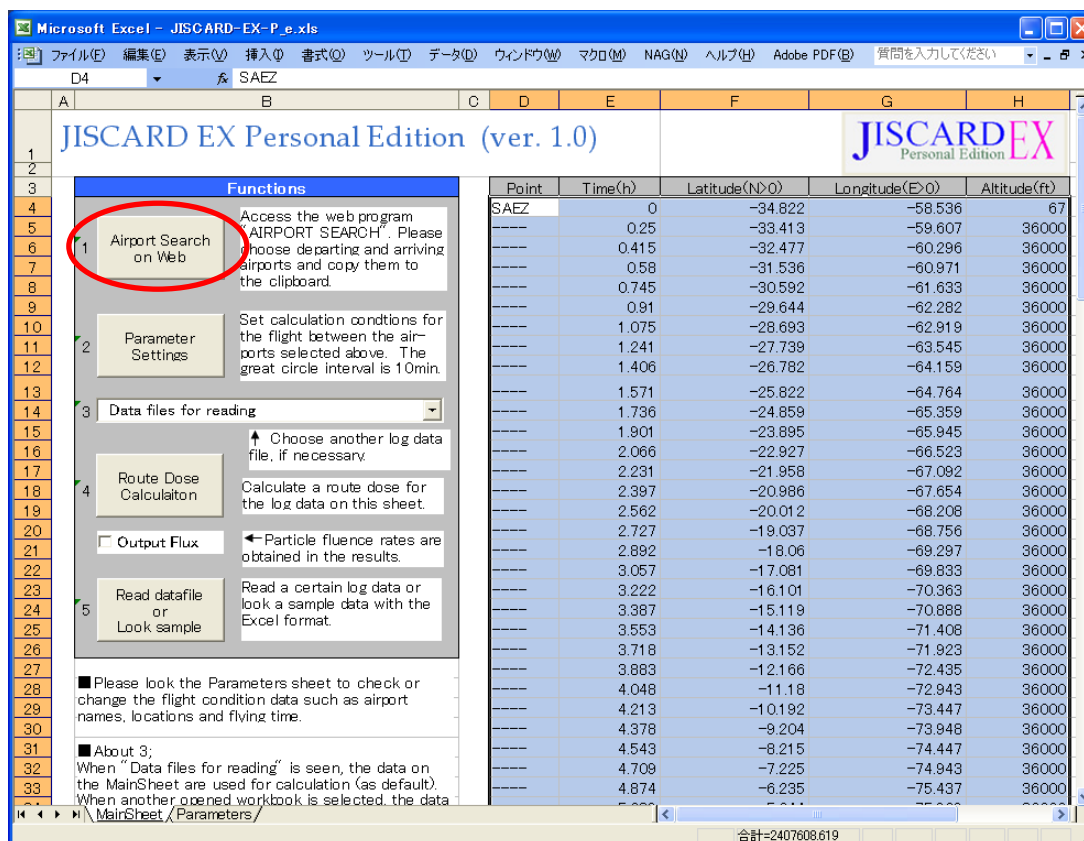


Shortly, calculation results including flight conditions, route doses (effective dose and 1cm ambient dose equivalent), solar magnetic potential, trend graphs (dose rate, altitude and geomagnetic cut-off rigidity potential) and the figure of flight route are automatically summarized in report style on another worksheet as shown below.



## 2-2. When flight path is unknown

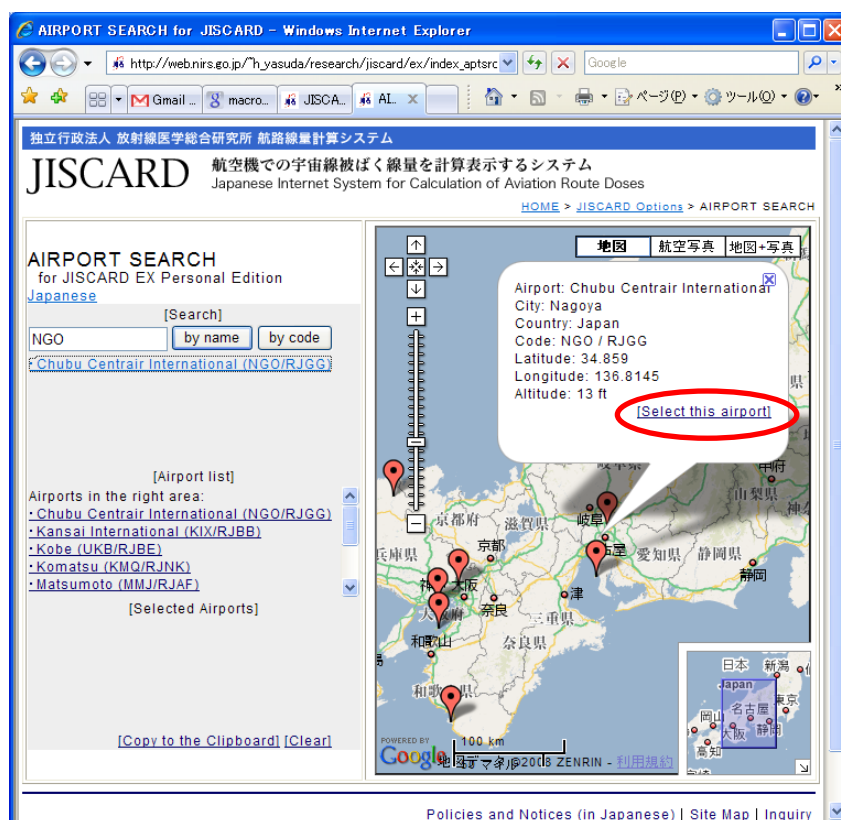
When flight path data are unavailable, you can get geographical information of airports from an original program. Push the “Airport Search on Web” button on the mainsheet.



A web tool “AIRPORT SEARCH”<sup>\*</sup> starts automatically on the web browser of your PC. Internet Explorer 6 or more is recommended for this tool. Adobe Flash (9.45 or more) is also necessary.

<sup>\*</sup>URL [http://www.nirs.go.jp/research/jiscard/ex/index\\_aptsrch\\_e.html](http://www.nirs.go.jp/research/jiscard/ex/index_aptsrch_e.html)

Input a part of airport or city name or code in the box and push “by name” or “by code” button, respectively. Clicking the full airport name that has appeared below the box, you find a balloon in the right box area of Google Maps. Check the information on the airport and, if it is what you looked for, click “Select this airport” in the balloon.



After selecting both departing/arriving airports, click “Copy to the Clipboard” at the bottom in the left box.



Gong back to the mainsheet, then push “Parameter Settings” button in the left panel.

The screenshot shows the JISCARD EX (Personal Edition ver.1.0) Excel spreadsheet. The left panel contains a 'Functions' menu with the following options:

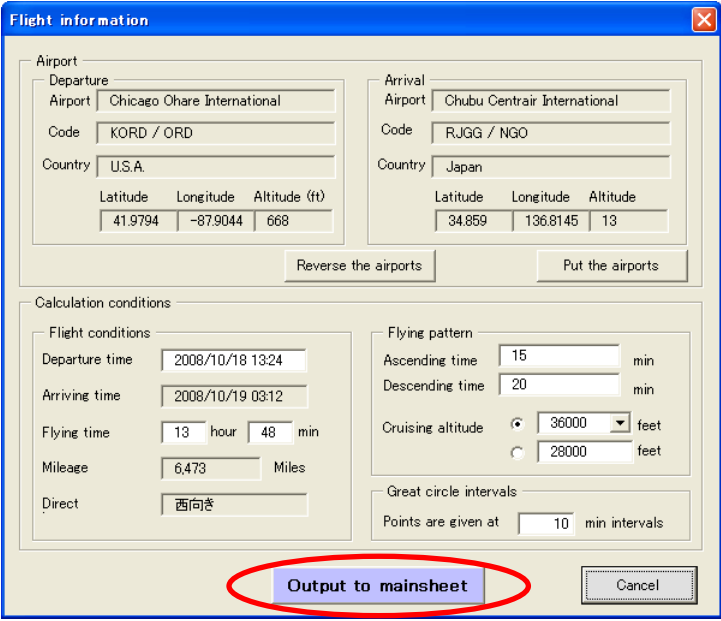
- ① Airport Search on Web: 空港検索ウェブシステム AIRPORT SEARCHにアクセスします。出発空港と到着空港の2つを選択してクリップボードにコピーしてください。
- ② Parameter Settings: 2つの空港間について、航路線量の計算条件を設定します。大円ルート補間のデフォルト時間間隔は10分です。
- ③ Data files for reading: 線量計算に用いる航路データを選択します。
- ④ Route Dose Calculation: 選択した航路データを用いて線量計算を行います。
- Output Flux: チェックすると、各粒子のフラックスを結果に出力します。
- ⑤ Read datafile or Look sample: 規定の書式で航路データが収録されているファイル(\*.xls)を読み込みます。

The main area displays a table of flight data points:

Point	Time(h)	Latitude(N>0)	Longitude(E>0)	Altitude(ft)
KLAX	0	33.943	-118.408	126
----	0.25	34.188	-116.428	36000
----	0.416	34.333	-115.106	36000
----	0.582	34.464	-113.781	36000
----	0.747	34.58	-112.451	36000
----	0.913	34.682	-111.118	36000
----	1.079	34.77	-109.782	36000
----	1.245	34.842	-108.443	36000
----	1.411	34.901	-107.102	36000
----	1.577	34.944	-105.759	36000
----	1.743	34.973	-104.416	36000
----	1.909	34.987	-103.071	36000
----	2.075	34.986	-101.727	36000
----	2.241	34.97	-100.382	36000
----	2.407	34.939	-99.039	36000
----	2.572	34.894	-97.697	36000
----	2.738	34.834	-96.356	36000
----	2.904	34.759	-95.017	36000
----	3.07	34.67	-93.682	36000
----	3.236	34.566	-92.349	36000
----	3.402	34.447	-91.02	36000
----	3.568	34.314	-89.694	36000
----	3.734	34.167	-88.373	36000
----	3.9	34.006	-87.057	36000
KATL	4.233	33.64	-84.427	1026

The bottom status bar shows the command: コマンド MainSheet / Parameters/

A pop-up panel shows information on flight conditions such as airport locations, flying date and time are displayed as shown below. Great circle route is calculated for points with 10min intervals in default. After confirmation and necessary modification, push “Output to mainsheet” button.



The image shows a 'Flight information' dialog box with a blue title bar and a close button. It is divided into several sections. The 'Airport' section at the top has two columns: 'Departure' and 'Arrival'. The 'Departure' column shows 'Chicago Ohare International' with code 'KORD / ORD' and country 'U.S.A.', and a table of coordinates (Latitude: 41.9794, Longitude: -87.9044, Altitude: 668). The 'Arrival' column shows 'Chubu Centrair International' with code 'RJGG / NGO' and country 'Japan', and a table of coordinates (Latitude: 34.859, Longitude: 136.8145, Altitude: 13). Below this are 'Reverse the airports' and 'Put the airports' buttons. The 'Calculation conditions' section is below, with 'Flight conditions' on the left (Departure time: 2008/10/18 13:24, Arriving time: 2008/10/19 03:12, Flying time: 13 hour 48 min, Mileage: 6,473 Miles, Direct: 西向き) and 'Flying pattern' on the right (Ascending time: 15 min, Descending time: 20 min, Cruising altitude: 36000 feet selected, 28000 feet also shown). Below the flying pattern is 'Great circle intervals' with 'Points are given at' 10 min intervals. At the bottom, the 'Output to mainsheet' button is highlighted with a red oval, and a 'Cancel' button is to its right.

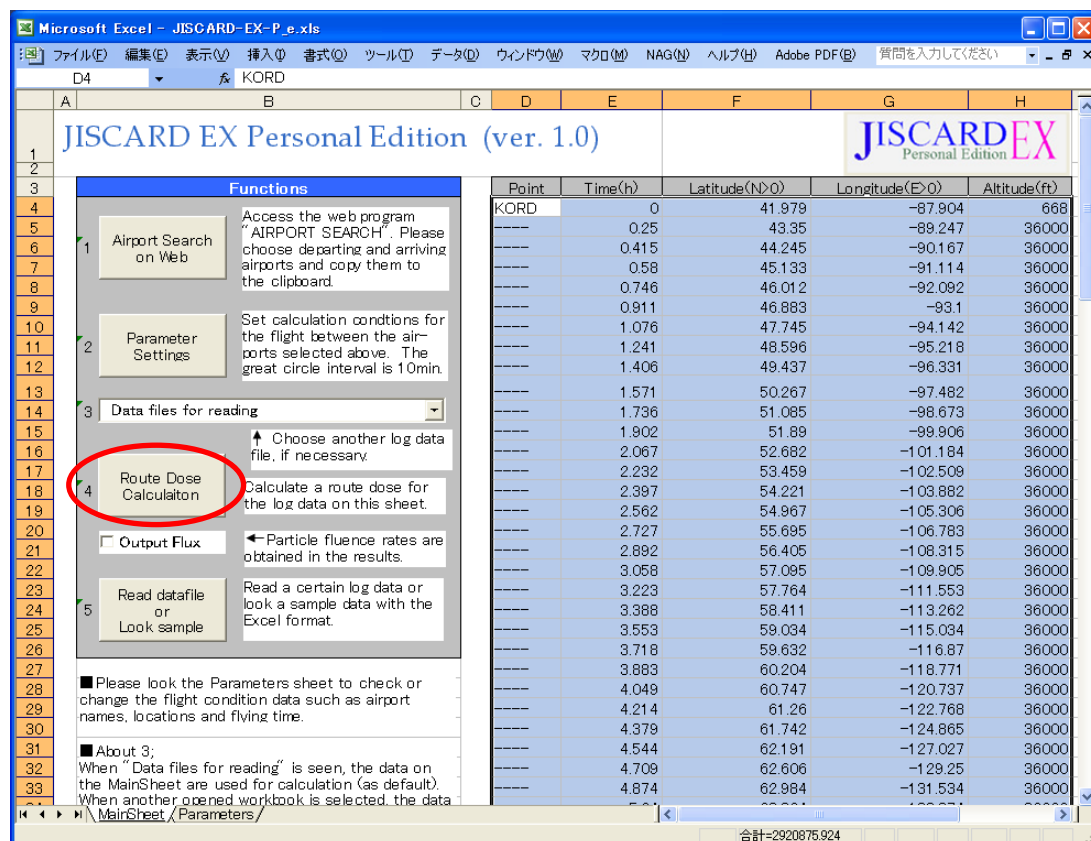
Airport	
Departure	Arrival
Airport: Chicago Ohare International	Airport: Chubu Centrair International
Code: KORD / ORD	Code: RJGG / NGO
Country: U.S.A.	Country: Japan
Latitude: 41.9794	Latitude: 34.859
Longitude: -87.9044	Longitude: 136.8145
Altitude (ft): 668	Altitude: 13

Reverse the airports      Put the airports

Calculation conditions	
Flight conditions	Flying pattern
Departure time: 2008/10/18 13:24	Ascending time: 15 min
Arriving time: 2008/10/19 03:12	Descending time: 20 min
Flying time: 13 hour 48 min	Cruising altitude: 36000 feet (selected)
Mileage: 6,473 Miles	28000 feet
Direct: 西向き	Great circle intervals
	Points are given at: 10 min intervals

Output to mainsheet      Cancel

Flight path data along the great circle route are automatically given on the mainsheet cells. Now you can push “Route Dose Calculation” button for the calculation of route dose. A summary report will be made soon.



Other boxes and buttons on the mainsheet are for optional use. Please ask the manufacturer (airdose@nirs.go.jp) for questions.

### **3. Program Description**

Cosmic radiation intensities at aviation altitude (10~12km) are much higher than those on the ground and most of aircraft crew receive additional doses of more than 1mSv per year, i.e. the dose limit recommended for the general public. Accordingly, ICRP states that radiation exposure during the operation of jet aircraft should be considered as occupational exposure [1,2]. This recommendation has been followed most in Europe; the European Union (EU) has made a directive which orders member countries to perform assessments of cosmic radiation exposure for aircraft crew [3].

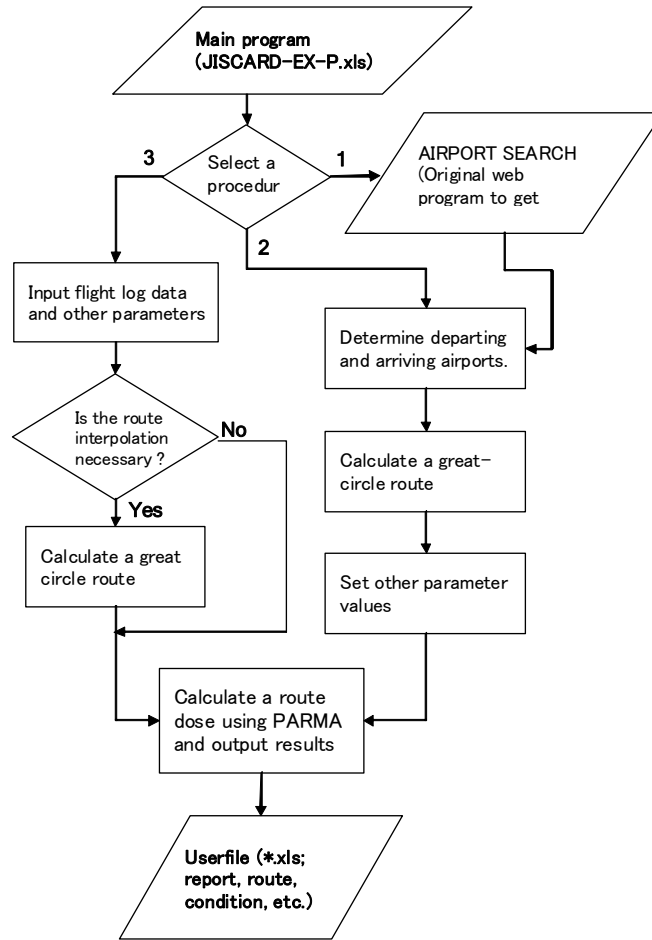
In Japan, the government has requested domestic airline companies to follow the guidelines made by the Radiation Council in 2006 [4] which states that annual aviation doses of aircraft crew are to be kept below 5mSv per year. The National Institute of Radiological Sciences (NIRS) has helped the airline companies to follow this guideline, particularly for calculation of aviation route doses. As a by-product of this work, this personal-use program, named as “JISCARD EX Personal Edition”, has been developed.

#### **3-1. Outline of the program**

This program is written with Excel VBA (Visual Basic for Applications) language and runs on the platform of Microsoft Excel 2003/2007. The dose rate at a point in the atmosphere is calculated using newly recommended radiation weighting factors [2] with a new analytical model that is recently developed in Japan [5].

The flow of tasks for route dose calculation is shown in Fig.1. To use this program, just open an Excel file with a default name of “JISCARD-EX-P\_e.xls”. On the first mainsheet as explained in the previous chapter, you can select one of three procedures according to how much flight path data are available. Also, as another procedure, a CSV-format data file of flight path can be uploaded from memory devices.





**Fig. 1:** The task flow of route dose calculation using JISCARD EX.

Geomagnetic cut-off rigidities ( $R_c$ ) at passing points are calculated with a GEANT4-base particle tracing code “MAGNETOCOSMICS” [6] developed by the cosmic ray group of the University of Bern. The newest version, which will be effective until 2010, is used here.

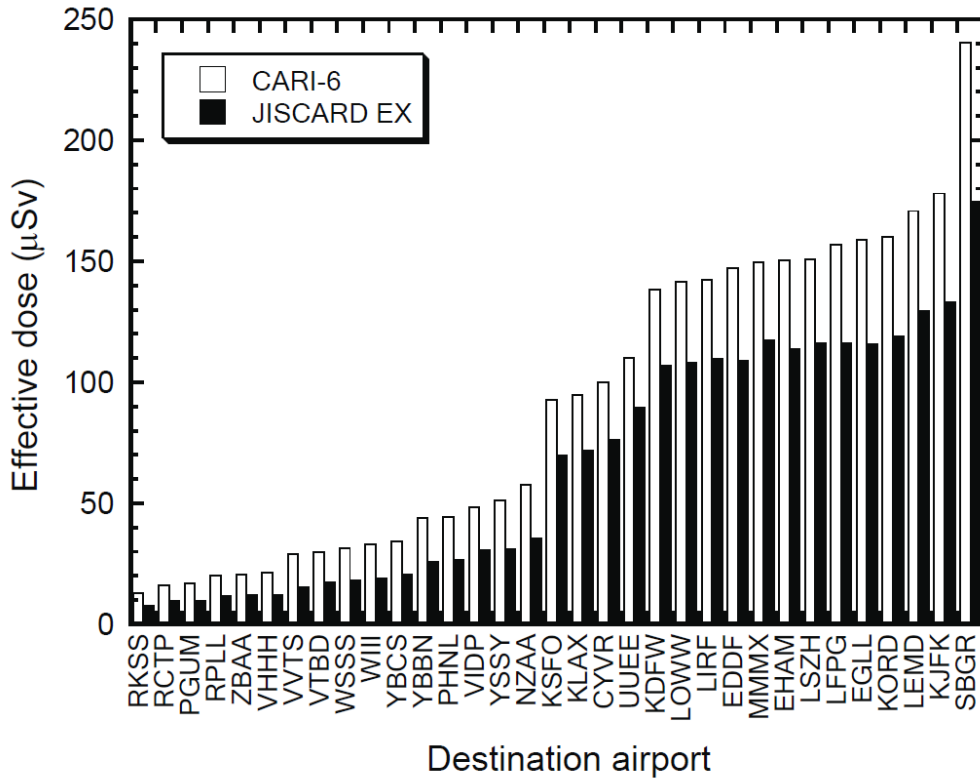
The incident particle spectra of galactic cosmic rays (GCR) around the Earth are given from the local interstellar (LIS) spectra. Effects of solar modulation are evaluated with the model of Nymmik et al.[7] coupled with modified empirical parameters based on the force field formalism.

According to the  $R_c$  values and GCR spectra that were independently estimated, cosmic radiation dose rates at passing points are calculated with the PHITS-based Analytical Radiation Model in the Atmosphere “PARMA” developed by Sato et al [5]. PARMA can calculate cosmic radiation doses in the atmosphere in a short time as precisely as Monte Carlo simulation (PHITS code) can. Total effective dose and 1cm ambient dose equivalent are obtained as integrals of dose rates along the flight path.

### **3-2. Comparison with Other Programs**

Several programs are now available for route dose calculation, such as CARI-6 [8], EPCARD [9], SIEVERT [10] and PCAIRE [11]. The characteristics of these models including properties of other models and services are well explained in a report by the European Radiation Dosimetry Group [12].

In Fig.2, effective doses calculated with JISCARD EX are compared to those with CARI-6 for selected international flights. The estimations of JISCARD EX are 20~50% (30% in average) lower than those with CARI-6; no higher value was found. The effective doses obtained with JISCARD EX are lower also than those with EPCARD [9] and SIEVERT [10], though the results are not shown here. The main reason for these results is due to the recent revision of the radiation weighting factor ( $w_R$ ) values [2]. The  $w_R$  values for neutrons are considerably lower than those in the 1990 recommendations [1]. Also, the difference is attributable to employment of the new model for radiation transport [5] which improved the accuracy for estimation of neutron energy spectra, particularly for cosmic-ray neutrons with energies greater than 10MeV.



**Fig.2:** Comparison of the effective doses calculated with CARI-6 and JISCARD EX for 33 round-trip international flights between major cities and Tokyo/Narita airport.

It should be noted that difference of ambient dose equivalent between JISCARD EX and other programs becomes smaller than that of effective dose, since the  $H^*(10)$  values obtained with JISCARD EX are about 20% higher than effective doses. Comparison with other programs for route dose calculation [8-11] may be valuable in discussing the uncertainties which accompany to cosmic radiation dosimetry, i.e. nuclear reactions of high-energy particles up to GeV.

Finally, this program is expected to be a useful tool for educational purposes to facilitate understanding of natural radiation in the environment and also radiation exposure in aircraft.

## Acknowledgements

The author thanks Dr. Tatsuhiko Sato, Japan Atomic Energy Agency, for his great efforts to develop the PARMA code. Sincere appreciation is expressed to Mr. Masato Terakado, Mr. Susumu Ryufuku and Mr. Takumi Ajima, Visible Information Center, Inc. for technical cooperation in the program development.

## References

- [1] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, The 1990 Recommendations of the International Commission on Radiological Protection, Publication 60, Pergamon Press, Oxford (1991)
- [2] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, The 2007 Recommendations of the International Commission on Radiological Protection, Publication 103, Pergamon Press, Oxford (2007)
- [3] EUROPEAN UNION, Council Directive 96/29/EURATOM of 13 May 1996 laying down the basic safety standards for protection of the health of workers and the general public against the dangers arising from ionizing radiation. Off. J. Eur. Commun. L159 (1996)
- [4] MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY, [http://www.mext.go.jp/b\\_menu/shingi/housha/sonota/06051009.htm](http://www.mext.go.jp/b_menu/shingi/housha/sonota/06051009.htm) (in Japanese)
- [5] SATO, T., YASUDA, H., NIITA, K., ENDO, A. AND SIHVER, L., "Development of PARMA: PHITS-based Analytical Radiation Model in the Atmosphere" Radiat. Res. 170, 244-259 (2008)
- [6] COSMIC RAY GROUP, PHYSIKALISCHES INSTITUT, UNIVERSITY OF BERN, <http://cosray.unibe.ch/~laurent/magnetocosmics/>
- [7] NYMMIK, R. A., PANASYUK, M. I., PERVAJA, T. I. AND SUSLOV, A. A., A model of galactic cosmic ray fluxes. Nucl. Tracks Radiat. Meas. 20, 427-429 (1992).

- [8] FEDERAL AVIATION ADMINISTRATION: Radiobiology Research Team web page,  
[http://www.faa.gov/education\\_research/research/med\\_humanfacs/aeromedical/radiobiology/cari6/index.cfm](http://www.faa.gov/education_research/research/med_humanfacs/aeromedical/radiobiology/cari6/index.cfm)
- [9] NATIONAL RESEARCH CENTER FOR ENVIRONMENT AND HEALTH: EPCARD, [http://www.gsf.de/epcard2/index\\_en.phtml](http://www.gsf.de/epcard2/index_en.phtml)
- [10] SIEVERT web page: <http://www.sievert-system.org/WebMasters/en/index.html>
- [11] PCAIRE Inc. : <http://www.pcaire.com/>
- [12] EUROPEAN RADIATION DOSIMETRY GROUP: “Cosmic radiation exposure of aircraft crew: compilation of measured and calculated data”, A report of EURADOS Working Group 5. European Commission: Luxembourg (2004)

# JISCARD EX Personal Edition ver.1.0

## User's Manual

Publisher: National Institute of Radiological Sciences  
9-1, Anagawa 4, Inage-ku, Chiba 263-8555, Japan

Author: Hiroshi Yasuda  
Research Center for Radiation Protection  
National Institute of Radiological Sciences

E-mail: airdose @ nirs.go.jp

Web page: [http://www.nirs.go.jp/research/jiscard/ex/index\\_ex\\_e.html](http://www.nirs.go.jp/research/jiscard/ex/index_ex_e.html)

\* A part of this document could be changed without notice.

\* This work is protected by copyright laws internationally.