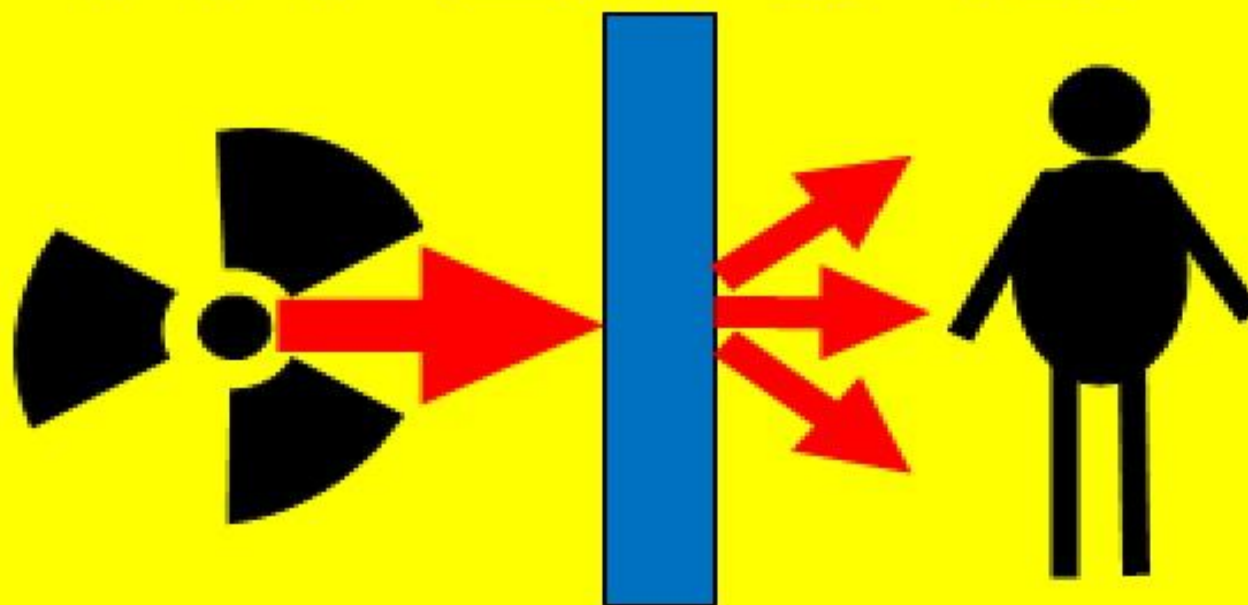


HYGIRAD



RADIATION DATA
TRANSMISSION

HYGIRAD

NUCLEAR DATA TRANSMISSIONS

APP

MEDPHYS Software & Services 2014

info@medphys.nl

DESCRIPTION OF THE PROGRAM:

The program calculates

- for a chosen NUCLIDE (or gamma-energy):

- + gamma and X-ray energies and yields for >300 nuclides,
- + transmission through one or more walls,
- + attenuation coefficients (μ/ρ) for >120 materials,
- + data needed for compliance with transport regulations;
- + Dose Coefficients for inhalation and ingestion,
- + Safety Values,
- + ambient dose equivalent values.

- for a chosen X-RAY instrument:

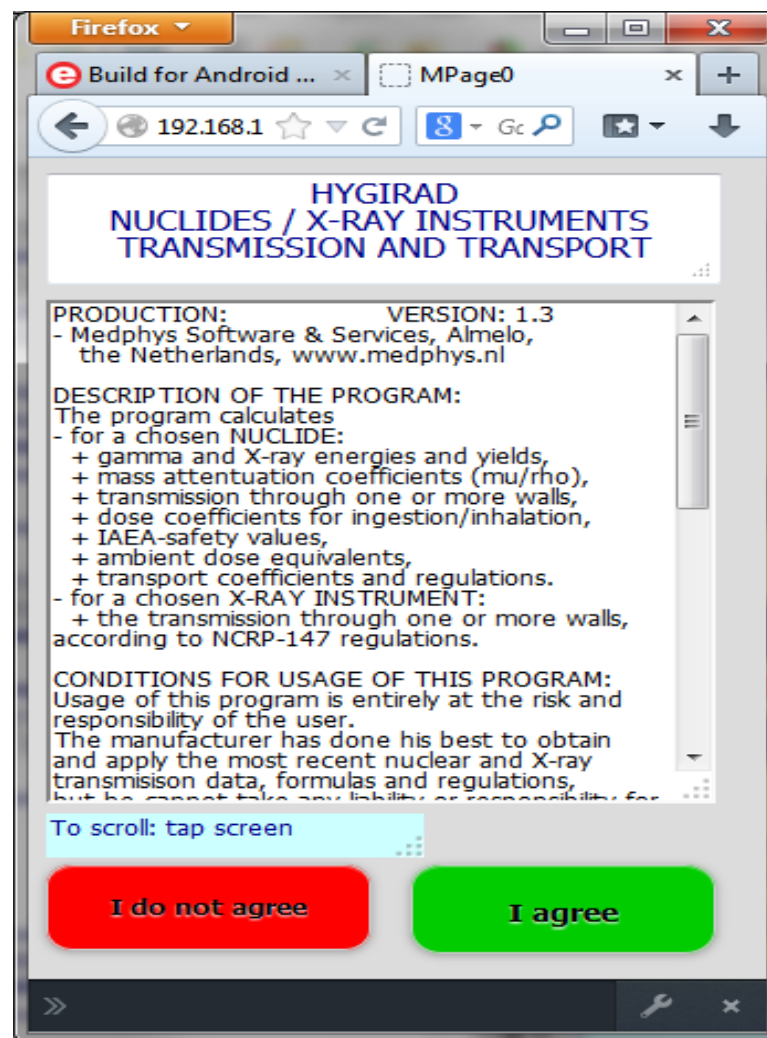
- + the transmission through one or more walls, according to NCRP-147 regulations

.

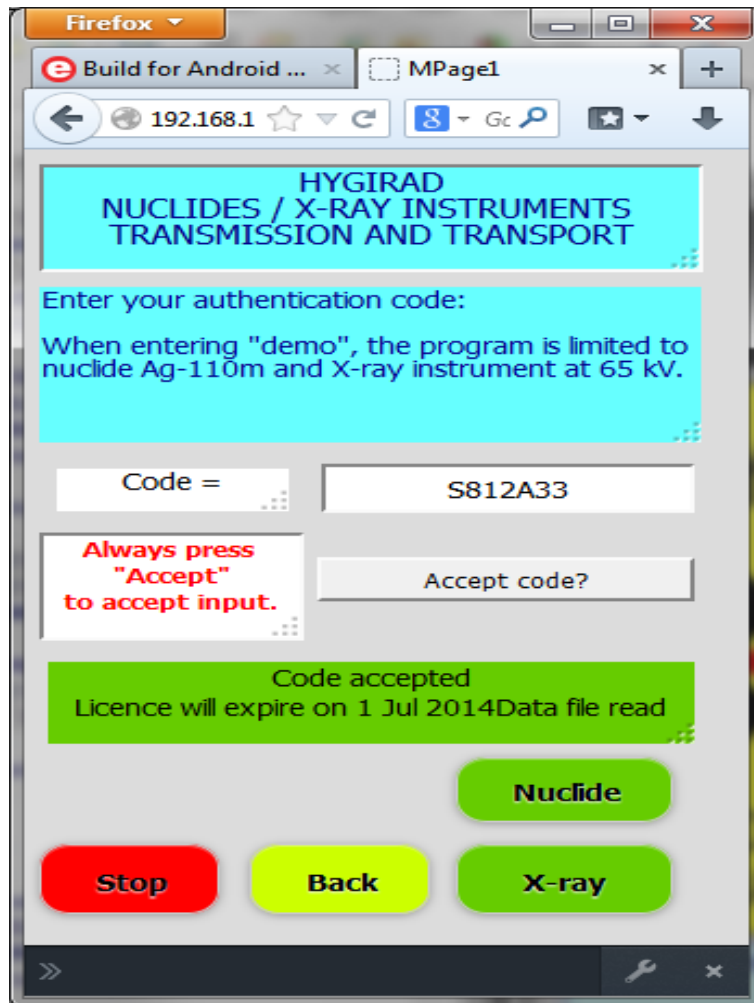
1. START



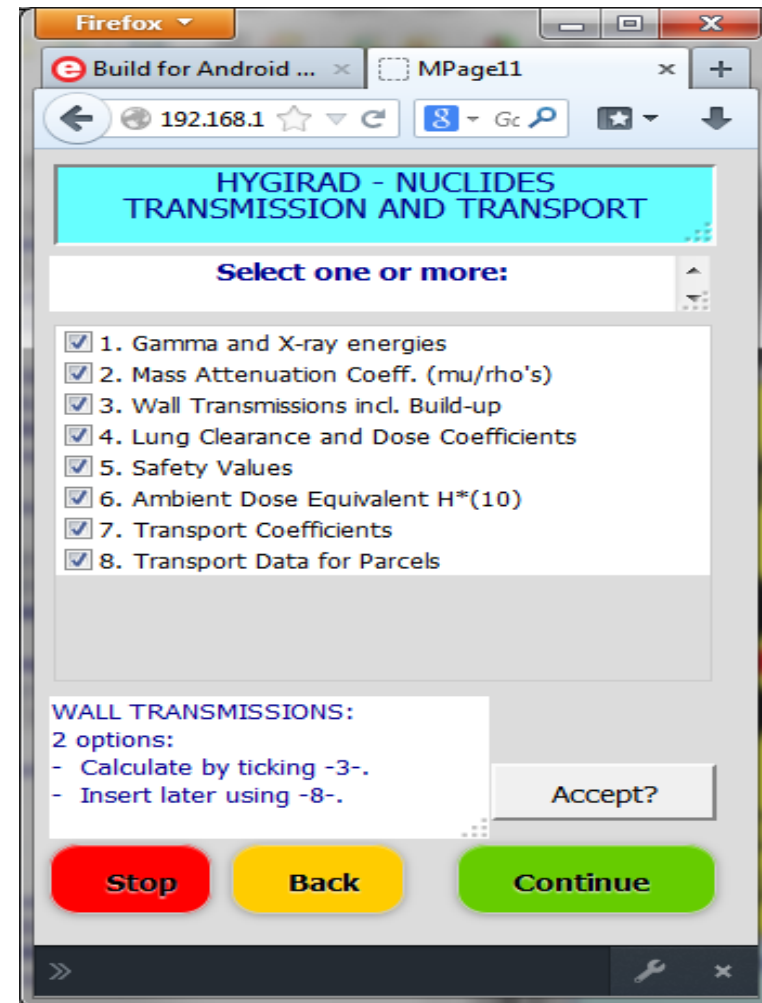
2. PROGRAM DESCRIPTION



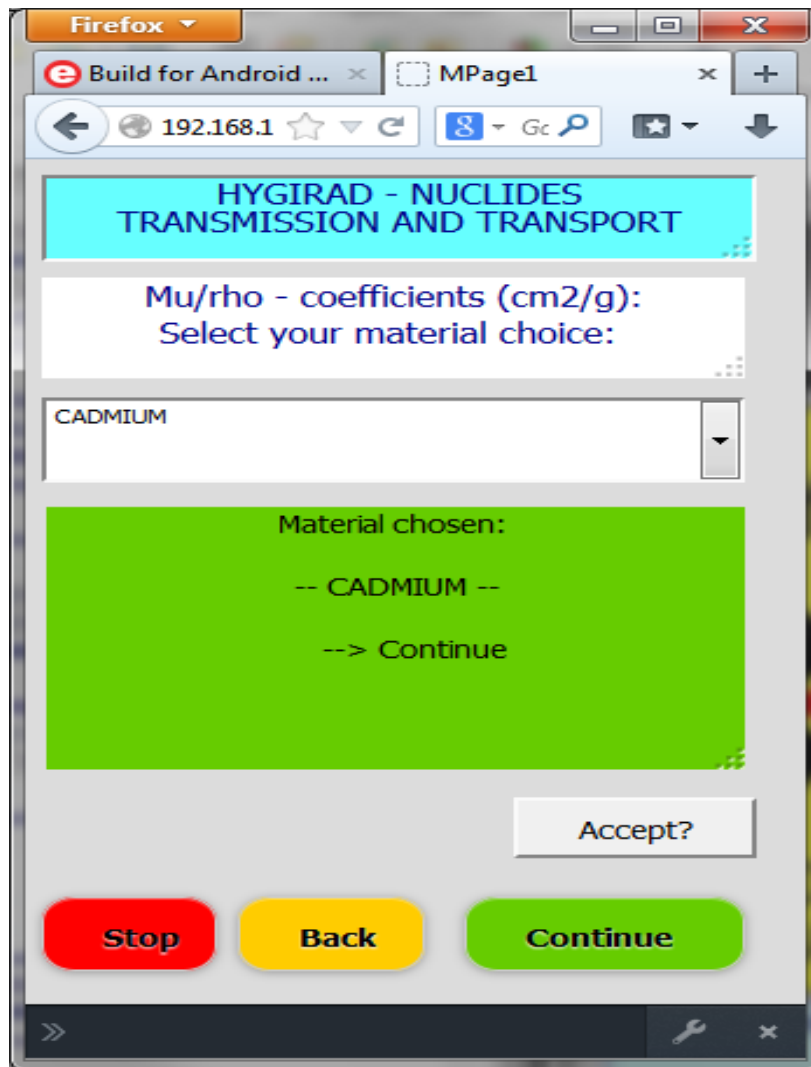
3.INSERTION OF ENTRANCE CODE



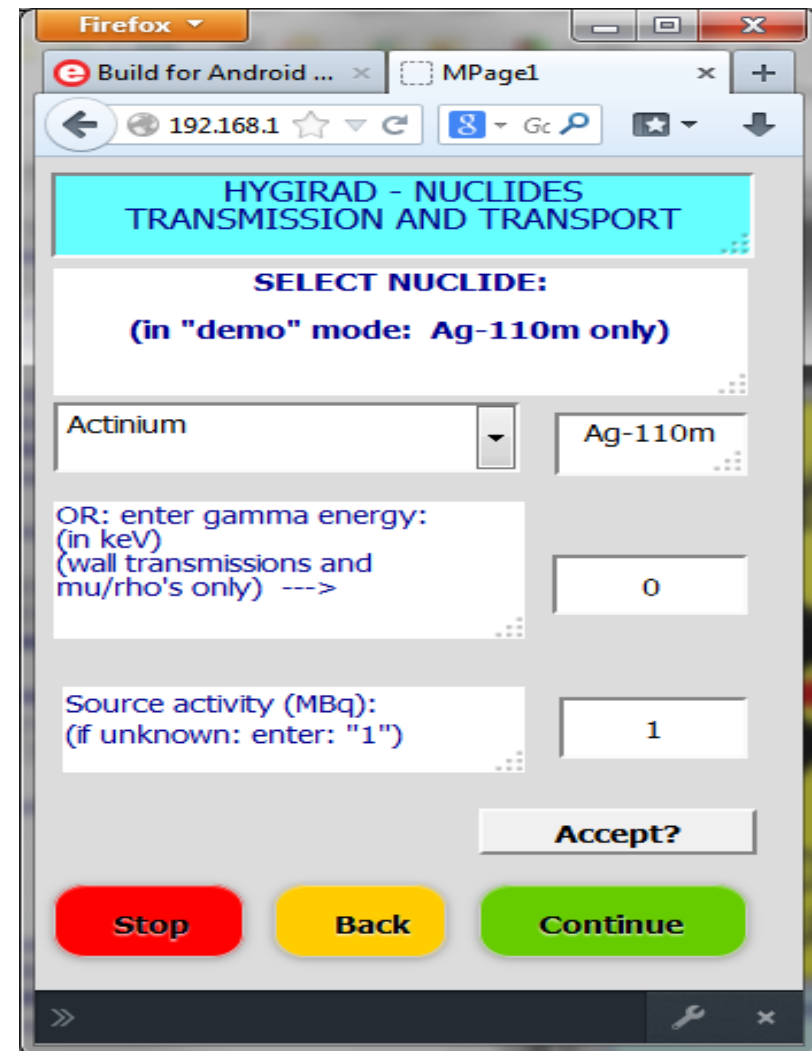
4.NUCLIDES: CALCULATION MODES



5. NUCLIDES : ATTENUATION COEFFS.



6 NUCLIDES: SELECTION



7. INSERTION OF WALL THICKNESSES

HYGI RAD - NUCLIDES TRANSMISSION AND TRANSPORT

SELECT WALL THICKNESS(ES)
thicknesses in cm
order 1..6 --> 1 = closest to source
if no walls: insert all thicknesses =0

wall material	thickness	order
Lead	0.1	1
Concrete	0	2
Iron	0	3
Aluminum	0	4
Water	0	5
	0	6

Data input OK.
-> Continue

Accept?

Stop Back Continue

Image1: Image
Origin: (8, 0); Size

8. SELECT BUILD-UP MODE

HYGI RAD - NUCLIDES TRANSMISSION AND TRANSPORT

Calculation mode for build-up:
(for distance dose or transport calculations)

- A- all walls have build-up
- B- all walls combined
- C- build-up for first wall only
- D- no build-up factors at all

TRANSMISSION AND BUILD-UP: DETAILS

TRANSMISSION = AVERAGE [BU * exp (-mu.d)] d = thickness; BU = build-up.
"Average" <..> to be taken over all gamma and X-ray-emissions, weighted according to their yields.

MASS ATTENUATION COEFFICIENTS (mu/rho):
calculated for each gamma and X-ray-emission,
and (if not emission energy) assumed as above

Accept?

Stop Back Continue

9. TRANSPORT DATA

Firefox

Build for Android ... x MPage23 x +

192.168.1

HYGIRAD - NUCLIDES
TRANSMISSION AND TRANSPORT

SELECT TRANSPORT DATA
(if not applicable: enter Mass = 0)

Mass of parcel (g)	10
Min. dimension of parcel (cm)	10
Transmission of package (<=1)....	1

Type of parcel:

Instrument

Nuclide

Physical condition:

Solid: special cond. (e.g. encapsulated)

Solid: other (e.g. open source)

Liquid

Gas: tritium

Gas: special cond. (e.g. encapsulated)

Gas: other (e.g. open source)

Accept?

Stop Back Continue

10. AMBIENT DOSE

Firefox

Build for Android ... x MPage1 x +

192.168.1

HYGIRAD - NUCLIDES
TRANSMISSION AND TRANSPORT

CALCULATION FOR: Ag-110m

Calc. of Ambient Dose:
Transmission value taken from:

wall transmission calc.

transport data

inserted value: ---->

1.0

Calc. of Ambient Dose:
Distance source - target (m):

1

Calculate

Stop Back

11.1. CALCULATIONS: RESULTS (part 1):

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

Nuclide = Ag-110m

GAMMA/X-RAY EMISSIONS:

	E keV	yield %
1	22.0	0.2
2	22.2	0.4
3	23.0	0.2
4	23.2	0.3
5	25.0	0.1
6	25.5	0.0
7	26.2	0.1
8	26.7	0.0
9	446.8	3.7
10	620.4	2.7
11	657.8	94.4
12	677.6	10.6
13	687.0	6.5
14	706.7	16.5
15	744.3	4.7
16	763.9	22.3
17	818.0	7.3
18	884.7	74.0
19	937.5	34.5
20	1384.3	24.7

(most important emissions only)
Half value time = 250 d

Buttons: Stop, Back, Continue

11.2. CALCULATIONS: RESULTS (part 2):

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

TRANSPORT COEFFICIENTS:

- A1 = 4.0E+05 MBq
- A2 = 4.0E+05 MBq
- Specific Activity = 1.0E+01 Bq/g
- Total Activity = 1.0E+06 Bq

SAFETY D-VALUE (IAEA 2006) = 2.0E+04 MBq
With activity A = 1 MBq -->
Safety value: A/D = 5.000E-05
category 5: most unlikely to be dangerous

CONTAMINATION:

LUNG CLEARANCE CLASSES :
(F = fast; M = moderate; S = slow;
D = gas/damp; E = extra ...)
F 0.050 unspecified compounds, metallic Ag
M 0.050 nitrates and sulfides
S 0.050 oxides, hydroxides, carbides

DOSE COEFFICIENTS : INHALATION [Sv/Bq]:
(E=employees; P=population > 17 y)
(if E or P= blank: take P or E-value.)

	E	P
- F	6.70E-09	5.5E-9
- M	5.90E-09	7.6E-9
- S	7.30E-09	1.2E-8

With activity = 1 MBq --> Dose =

	E	P
- F	6.70E-03	5.50E-03 Sv
- M	5.90E-03	7.60E-03 Sv
- S	7.30E-03	1.20E-02 Sv

DOSE COEFFICIENTS : INGESTION [Sv/Bq]

Buttons: Stop, Back, Continue

192.168.1.4:3571/TransApp26.php

11.3. CALCULATIONS: RESULTS (part 3):

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

DOSE COEFFICIENTS : INGESTION [Sv/Bq]
and f1-value(s) :
- all compounds: 2.8E-9 ; 0.050
With activity = 1 MBq --> Dose = 2.800E-03 Sv

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

Nuclide = Ag-110m

NUCLIDE: Ag-110m

MU/RHO's for: BISMUTH (rho= 9.780 g/cm3).
E yield mu/rho's [cm2/g] :
keV % mu/rho mu_tr/rho mu_en/rho

	E keV	yield %	mu/rho	mu_tr/rho	mu_en/rho
1	22	0.2	75.7260	61.7820	61.7140
2	22	0.4	74.5856	60.8932	60.8254
3	23	0.2	70.0240	57.3380	57.2710
4	23	0.3	68.8836	56.4492	56.3824
5	25	0.1	58.6200	48.4500	48.3850
6	26	0.0	55.7690	46.2280	46.1635
7	26	0.1	51.7776	43.1172	43.0534
8	27	0.0	48.9266	40.8952	40.8319
9	447	3.7	0.18966	0.12386	0.11927
10	620	2.7	0.11595	0.07118	0.06787
11	658	94.4	0.10963	0.06685	0.06364
12	678	10.6	0.10629	0.06455	0.06141
13	687	6.5	0.10470	0.06346	0.06034
14	707	16.5	0.10137	0.06118	0.05812
15	744	4.7	0.09502	0.05682	0.05387

Stop Back Continue

11.4. CALCULATIONS: RESULTS (part 4):

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

11	658	94.4	0.10963	0.06685	0.06364
12	678	10.6	0.10629	0.06455	0.06141
13	687	6.5	0.10470	0.06346	0.06034
14	707	16.5	0.10137	0.06118	0.05812
15	744	4.7	0.09502	0.05682	0.05387
16	764	22.3	0.09171	0.05455	0.05166
17	818	7.3	0.08412	0.04941	0.04665
18	885	74.0	0.07860	0.04589	0.04323
19	938	34.5	0.07423	0.04311	0.04051
20	1384	24.7	0.05428	0.03088	0.02845

<mu/rho> [cm2/g] 0.37237 0.28488 0.28171

WALL TRANSMISSION (%) (= BU*exp(-mu.d)) :
Wall(s) : order 1 : 0.10 cm Lead
(order 1..6: 1 = closest to source)

	E keV	yield %	Wall Transmission mode A	mode B	mode C	mode I
1	22	0.2	0.00000	0.00000	0.00000	0.00000
2	22	0.4	0.00000	0.00000	0.00000	0.00000
3	23	0.2	0.00000	0.00000	0.00000	0.00000
4	23	0.3	0.00000	0.00000	0.00000	0.00000
5	25	0.1	0.00000	0.00000	0.00000	0.00000
6	26	0.0	0.00000	0.00000	0.00000	0.00000
7	26	0.1	0.00000	0.00000	0.00000	0.00000
8	27	0.0	0.00000	0.00000	0.00000	0.00000
9	447	3.7	0.85550	0.85550	0.85550	0.80944
10	620	2.7	0.91718	0.91718	0.91718	0.87831
11	658	94.4	0.92277	0.92277	0.92277	0.88448
12	678	10.6	0.92570	0.92570	0.92570	0.88778
13	687	6.5	0.92709	0.92709	0.92709	0.88938
14	707	16.5	0.92998	0.92998	0.92998	0.89264

Stop Back Continue

11.5. CALCULATIONS: RESULTS (part 5)

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

13	687	6.5	0.92709	0.92709	0.92709	0.88938
14	707	16.5	0.92998	0.92998	0.92998	0.89264
15	744	4.7	0.93546	0.93546	0.93546	0.89896
16	764	22.3	0.93829	0.93829	0.93829	0.90227
17	818	7.3	0.94443	0.94443	0.94443	0.90991
18	885	74.0	0.94853	0.94853	0.94853	0.91553
19	938	34.5	0.95174	0.95174	0.95174	0.92000
20	1384	24.7	0.96276	0.96276	0.96276	0.93948
total			0.93347	0.93347	0.93347	0.89887

mode -A- all walls BU (build-up)
mode -B- all walls combined
mode -C- only first wall BU
mode -D- no BU at all

Build-up mode: -A- all walls BU (build-up)
Total wall transmission = 0.933473

AMBIENT DOSE EQUIVALENT :

- Source activity A = 1 MBq
- Distance to source = 1 m
- Source constant (Ambient Dose Equiv. constant) h(10) = 4.200E-01 uSv.m²/MBq/h
- Transmission (from: Wall transmission) = 9.335E-01
- Ambient Dose Equivalent H⁺(10) = 4.200E-01 uSv/h = 3.682E+00 mSv/y
- Idem, incl. Transmission = 3.921E-01 uSv/h = 3.437E+00 mSv/y

Buttons: Stop, Back, Continue

11.6. CALCULATIONS: RESULTS (part 6)

HYGIRAD - NUCLIDES TRANSMISSION AND TRANSPORT

TRANSPORT DATA: (uSv=microSv)

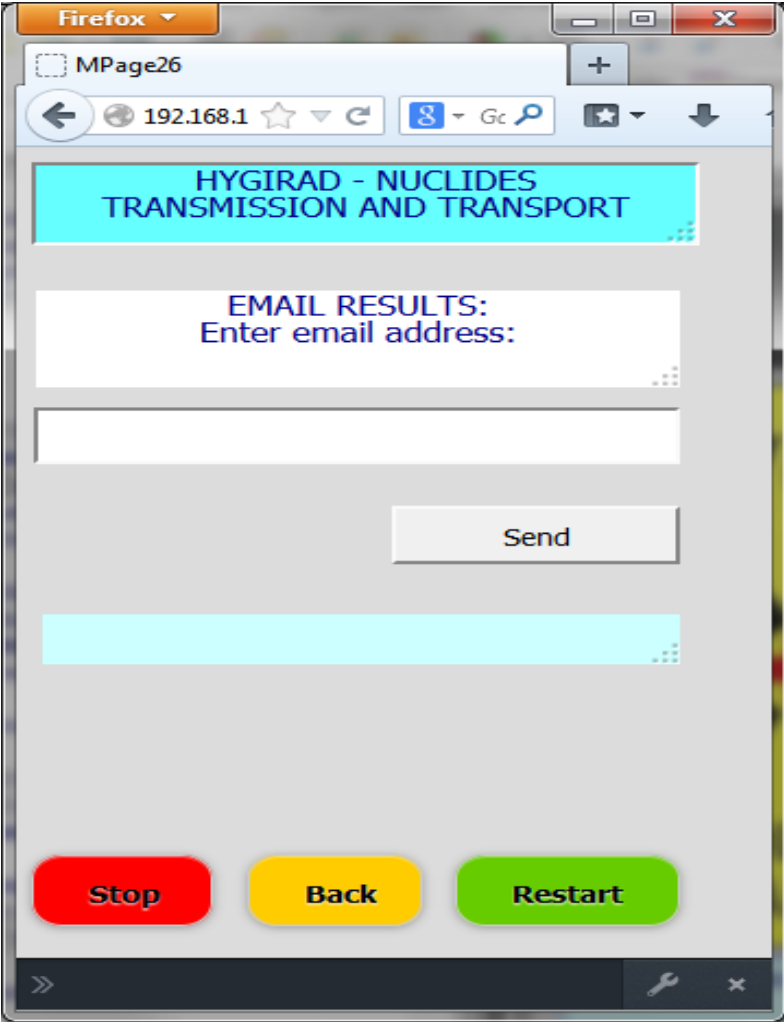
- Mass of parcel = 10.00 g
- Minimum dimension = 10.00 cm
- Transmission (from wall transm.) = 9.335E-01
- Spec. act. in parcel = 1.000E+05 Bq/g
- > 1.00E+01 Bq/g - TOO LARGE !!
- Total act. in parcel = 1.000E+00 MBq
- <= 1.00E+00 MBq - within limit
- Ambient dose equivalent:
- at surface = 1.568E+02 uSv/h
- <= 2.00E+03 uSv/h - within limit
- id. at 1 m from surface = 3.556E-01 uSv/h
- <= 1.00E+02 uSv/h - within limit
- Transport Index = 0.0
- Extra shielding : not needed.
- Excepted package? no, because:
- Act. > limit for parcel (4.000E-04 MBq) !!
- Ambient dose equiv. at surf. = 1.568E+02 > 5.000E+00 uSv/h - TOO LARGE !!
- Ambient dose equiv. at 3 m unshielded = 4.200E-04 <= 1.000E+01 mSv/h - OK.
- LSA-packaging (IP) allowed: type: LSA-II (see Regulations)
- Labeling of the package: I-white

end of table

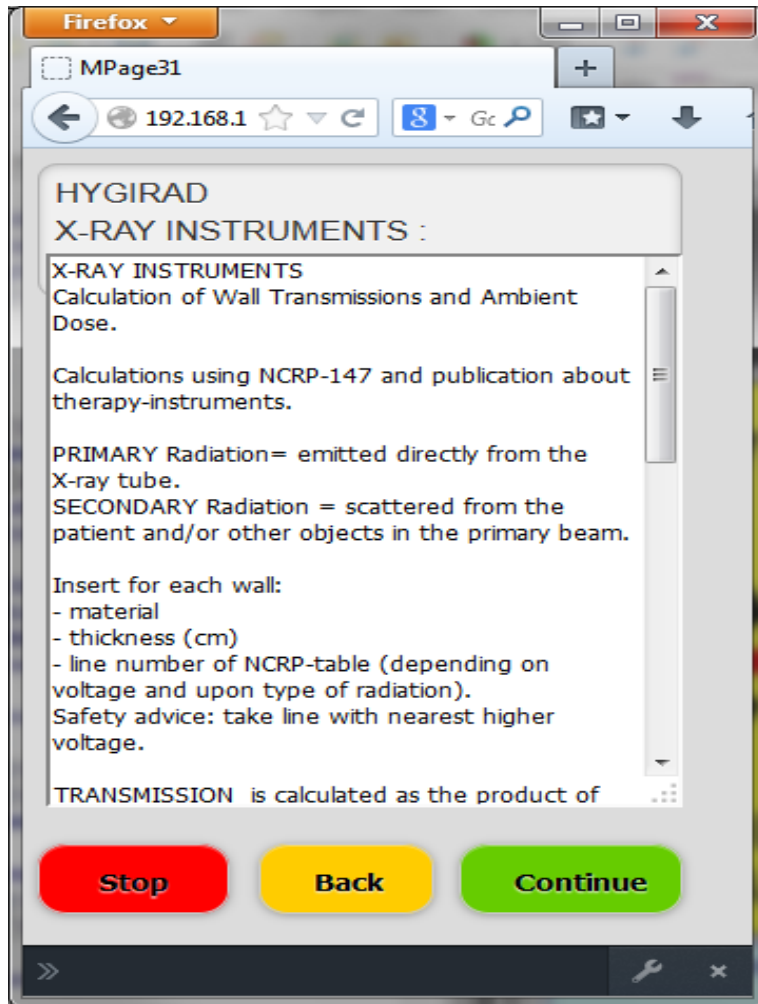
Buttons: Stop, Back, Continue

Image1: Image Origin: (8, 0); Size

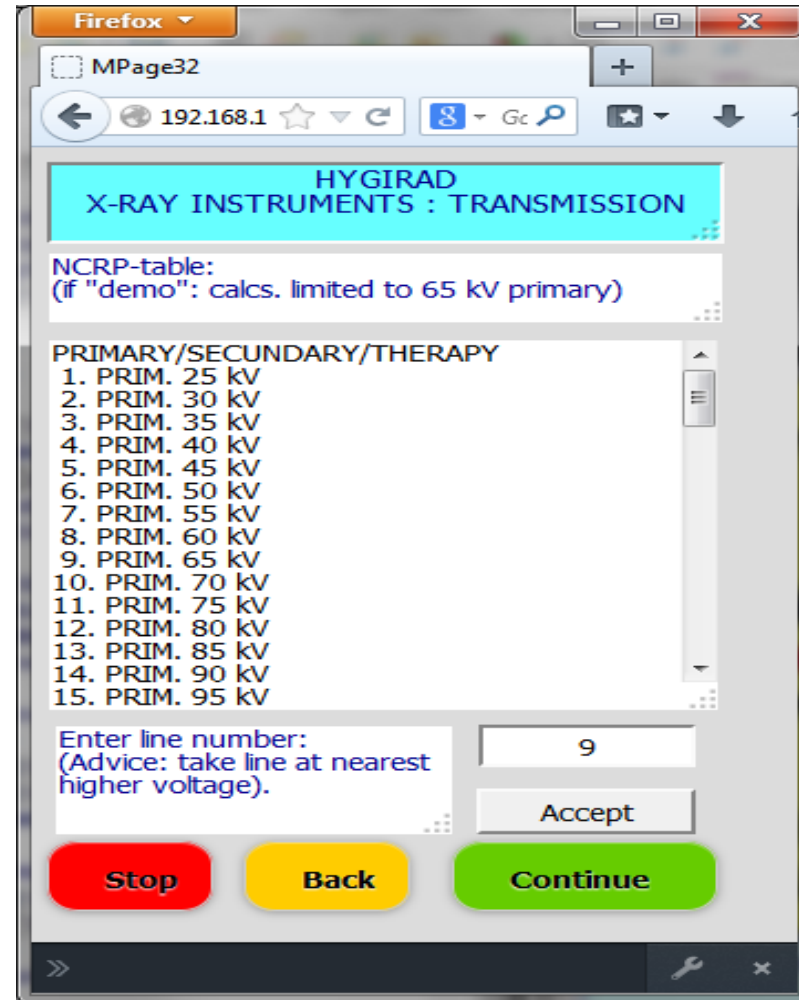
12. CALCULATIONS: EMAIL RESULTS



13. X-RAY INSTRUMENTS: DESCRIPTION



14. CHOICE OF VOLTAGE AND TYPE OF RADIATION



15. INSERTION OF WALL THICKNESSES

Firefox MPage1 192.168.1

HYGIRAD X-RAY INSTRUMENTS : TRANSMISSION

NCRP-line: 9 :
PRIM. 65 kV

Wall material	Thickness (cm)
Lead	0.1
Concrete	0
Gypsum	0
Steel	0
Glass	0
Wood	0

Thickness(es) OK:

Accept?

Stop Back Continue

16. INSERTION OF DOSE RATES AND DISTANCES; CALCULATIONS, RESULTS

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HYGIRAD X-RAY INSTRUMENTS : TRANSMISSION

- Dose rate at reference point (mSv/h)	10
- Distance of reference point to source (m)	2
- Distance of measurement point to source (m)	20
- # hours per year in use (h/y)	100

Calculate

X-ray instrument: PRIM. 65 kV

```
- Wall(s) | transmission:  
- 1 : 0.100 cm Lead | 9.767E-03 %  
- Transmission = 9.767E-03 %  
- Dose rate at measurement point =  
  9.767E-06 mSv/h  
  9.767E-04 mSv/y  
  9.767E-01 uSv/y
```

Stop Back

END OF CALCULATIONS