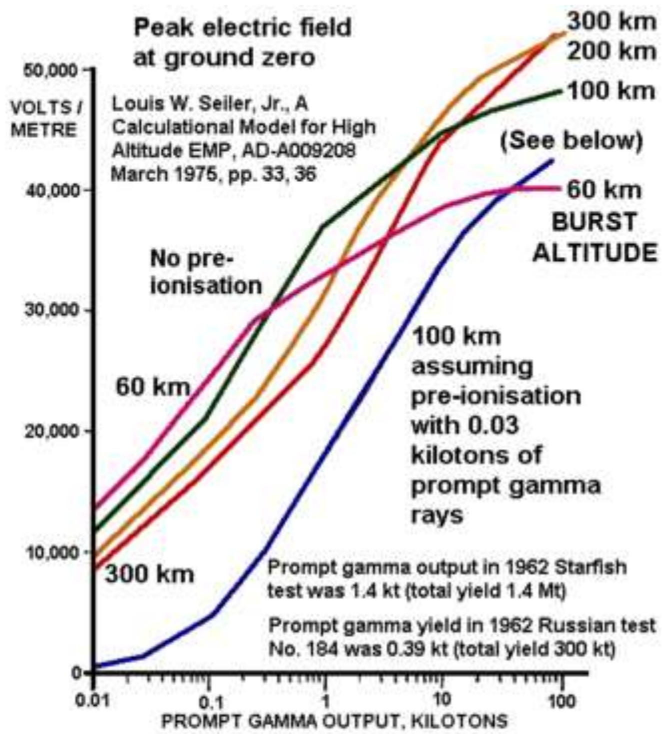
Addenda to Chapman's EMP Model – Inputs

The origin of the coordinate system is always at ground zero, directly below the burst.

Referring to the above coordinate system the target coordinates, (X, Y, Z), are read in using units of meters. If the reflected wave is to be calculated the altitude is read in as a negative number, (X, Y,-Z).
The height of the burst is read in using units of kilometers.

The gamma yield of the burst is read in using units of kilotons.
The chart below show values for gamma yield. Chapman's model notes that gamma yield should be below 1KT. So, it should track for a weapon up to 1MT if the relationship is somewhat linear (1.4KT/1.4MT or 1400KT=.001 and .39KT/300KT=.0013), which it appears to be. So, it may be possible to use a gamma yield factor of .001 of the weapon yield in KT, up to the point of a 1MT weapon. In any event, most current weapons are 300KT or less, so this relationship should hold.

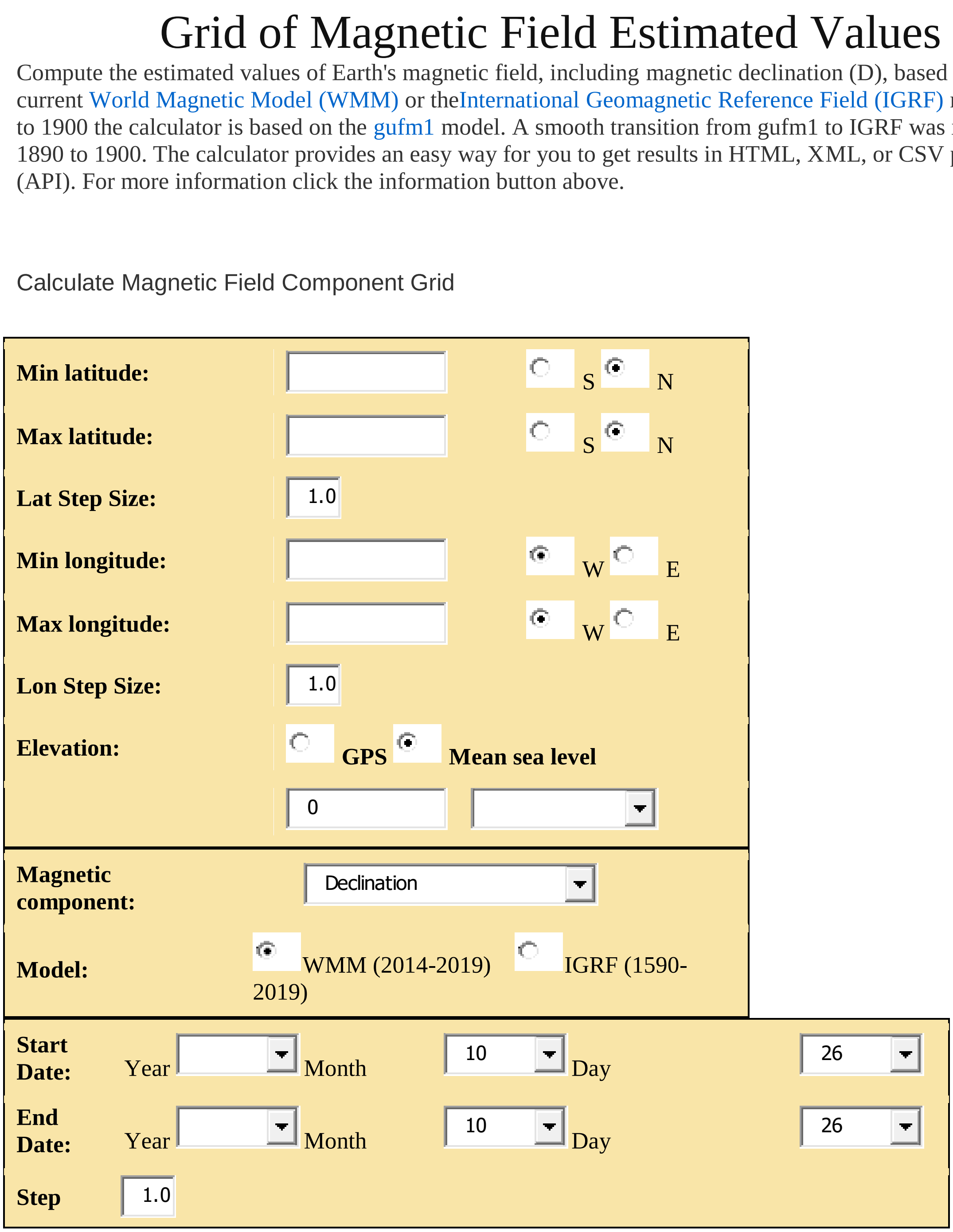
Also note that this chart is calculated at 50,000 v/m. I would guess that a "super EMP" weapon of 100,000 v/m to 200,000 v/m would be multiples of the .001 factor, but have no empirical evidence to validate that.



The total prompt gamma ray energy in a fission explosion is 3.5% of the yield, but in a 10 kiloton detonation the triggering explosive around the bomb core absorbs about 85% of the prompt gamma rays, so the output is only about 0.5% of the yield. In the thermonuclear Starfish Prime the fission yield was less than 100% and the thicker outer casing absorbed about 95% of the prompt gamma rays from the pusher around the fusion stage. Thermonuclear weapons are also less efficient at producing EMP because the first stage can pre-ionize the air which becomes conductive and hence rapidly shorts out the Compton currents generated by the fusion stage. Hence, small pure fission weapons with thin cases are far more efficient at causing EMP than most megaton bombs.

With regards to the magnetic field strength at the point of detonation, the following link has a calculator, which I have taken a picture of below:

https://www.ngdc.noaa.gov/geomag/magfield.shtml



Grid of Magnetic Field Estimated Values

Compute the estimated values of Earth's magnetic field, including magnetic declination (D), based on the current World Magnetic Model (WMM) or theInternational Geomagnetic Reference Field (IGRF) model. For 1590 to 1900 the calculator is based on the gufm1 model. A smooth transition from gufm1 to IGRF was imposed from 1890 to 1900. The calculator provides an easy way for you to get results in HTML, XML, or CSV programmatically (API). For more information click the information button above.

Calculate Magnetic Field Component Grid

Min latitude:		S N
Max latitude:		S N
Lat Step Size:	1.0	
Min longitude:		W E
Max longitude:		W E
Lon Step Size:	1.0	
Elevation:	**GPS** **Mean sea level**	
	0	
Magnetic component:	Declination	
Model:	WMM (2014-2019) IGRF (1590-2019)	

Start Date:	Year		Month	10	Day	26
End Date:	Year		Month	10	Day	26
Step	1.0					

size:		
Result format:	XML	CSV

Calculate

I used coordinates for New Orleans, 29° 57' 23" N and 90° 5' 55" W.

<?xml version="1.0"?>
<maggridresult><version> 0.5.0.7 </version><result><date> 2017.81644 </date><latitude units="**degree**"> 29.95639 </latitude><longitude units="**degree**"> -90.09861 </longitude><elevation units="**km**"> 0.00000 </elevation><totalintensity units="**nanotesla (nt)**"> 47170.1 </totalintensity><totalintensity_sv units="**nanotesla (nt)**"> -113.3 </totalintensity_sv><totalintensity_uncertainty units="**nanotesla (nt)**"> 152 </totalintensity_uncertainty></result></maggridresult>

The output will give a value of nanotesla (nT) which can be converted to Weber per square metre (Wb/m^2) here:

http://www.unit-conversion.info/magnetic-field.html

This model will also calculate magnetic inclination:

<?xml version="1.0"?>
<maggridresult><version> 0.5.0.7 </version><result><date> 2017.81644 </date><latitude units="**degree**"> 29.95639 </latitude><longitude units="**degree**"> -90.09861 </longitude><elevation units="**km**"> 0.00000 </elevation><inclination units="**degree**"> 59.25448 </inclination><inclination_sv units="**degree**"> -0.05685 </inclination_sv><inclination_uncertainty units="**degree**"> 0.22000 </inclination_uncertainty></result></maggridresult>

For calculating the magnetic dip angle (magnetic inclination) in degrees, the following model may be used:

http://www.magnetic-declination.com/

http://geomag.nrcan.gc.ca/calc/mfcal-en.php

Magnetic field calculator

Date (YYYY-MM-DD)
(1900-01-01 to 2020-01-31)

Latitude
(between 0 and 90)

0

North South

Longitude
(between 0 and 180)

0

West East

Calculate

Instructions

Date

The range of dates permitted with the International Geomagnetic Reference Field (IGRF-12) ranges from 1900 and 2020.

Latitude and Longitude

When entering the geographic latitude or longitude use one of the following three conventions:

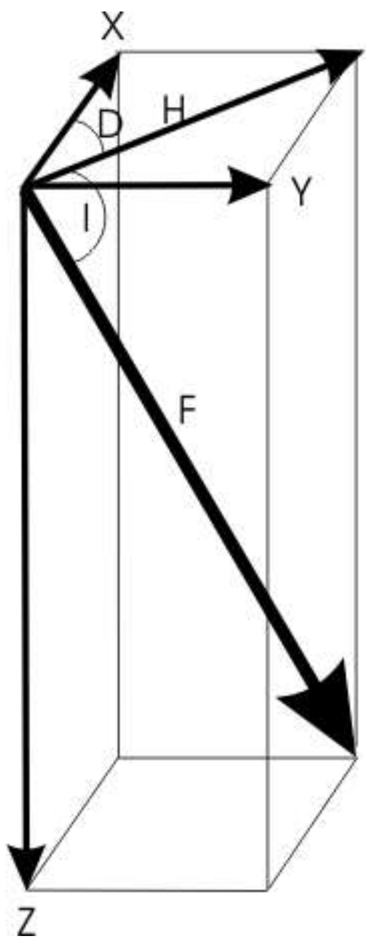
- Decimal degrees to a maximum of three decimal places, e.g., 45.738. Choose North or South, East or West from the 'radio' buttons.
- Degrees and minutes, e.g. 45 54.3. Choose North or South, East or West from the 'radio' buttons.
- Degrees, minutes, and seconds, e.g. 45 54 3.3. Input seconds will be rounded to the nearest second in the output. Choose North or South, East or West from the 'radio' buttons.

Magnetic components

The Earth's magnetic field is a vector quantity; at each point in space it has a strength and a direction. To completely describe it we need three quantities. These may be:

- three orthogonal strength components (**X**, **Y**, and **Z**);
- the total field strength and two angles (**F**, **D**, **I**); or
- two strength components and an angle (**H**, **Z**, **D**)

The relationship between these 7 elements is shown in the diagram.



Magnetic components

Component	Description
F	the total intensity of the magnetic field vector

H	the horizontal intensity of the magnetic field vector
Z	the vertical component of the magnetic field vector; by convention Z is positive downwa
X	the north component of the magnetic field; X is positive northward
Y	the east component of the magnetic field; Y is positive eastward
D	magnetic declination, defined as the angle between true north (geographic north) and th north (the horizontal component of the field). D is positive eastward of true North.
I	magnetic inclination, defined as the angle measured from the horizontal plane to the ma vector; downward is positive

D and **I** are measured in degrees. All other elements are measured in nanotesla (nT; 1 nT = 10^{-9} Tesla).

Note that you will need latitude and longitude as an integer number only, e.g., 90 degrees would be input as 90, with no minutes or seconds. Inputting 29 degrees N for latitude and 90 degrees W for longitude gives an inclination, or dip angle, of 58.361 degrees

Magnetic field calculator - Results

IGRF-12 (2015) Model Results

- Latitude: 29.0000° North
- Longitude: 90.0000° West
- Date: 2017-10-26

D (°)	I (°)	H (nT)	Z (nT)	F (nT)	X (nT)	Y (n
-0.800	58.361	24,436	39,660	46,584	24,434	

Note that this model differs slightly from the prior model due to brevity of input, i.e., degrees, not degrees, minutes and seconds.