

## Session 1:

“Setting the scene –the HEU-fuelled universe”

# HEU-fuelled sub-universes

(i) The World

(ii) South Asia

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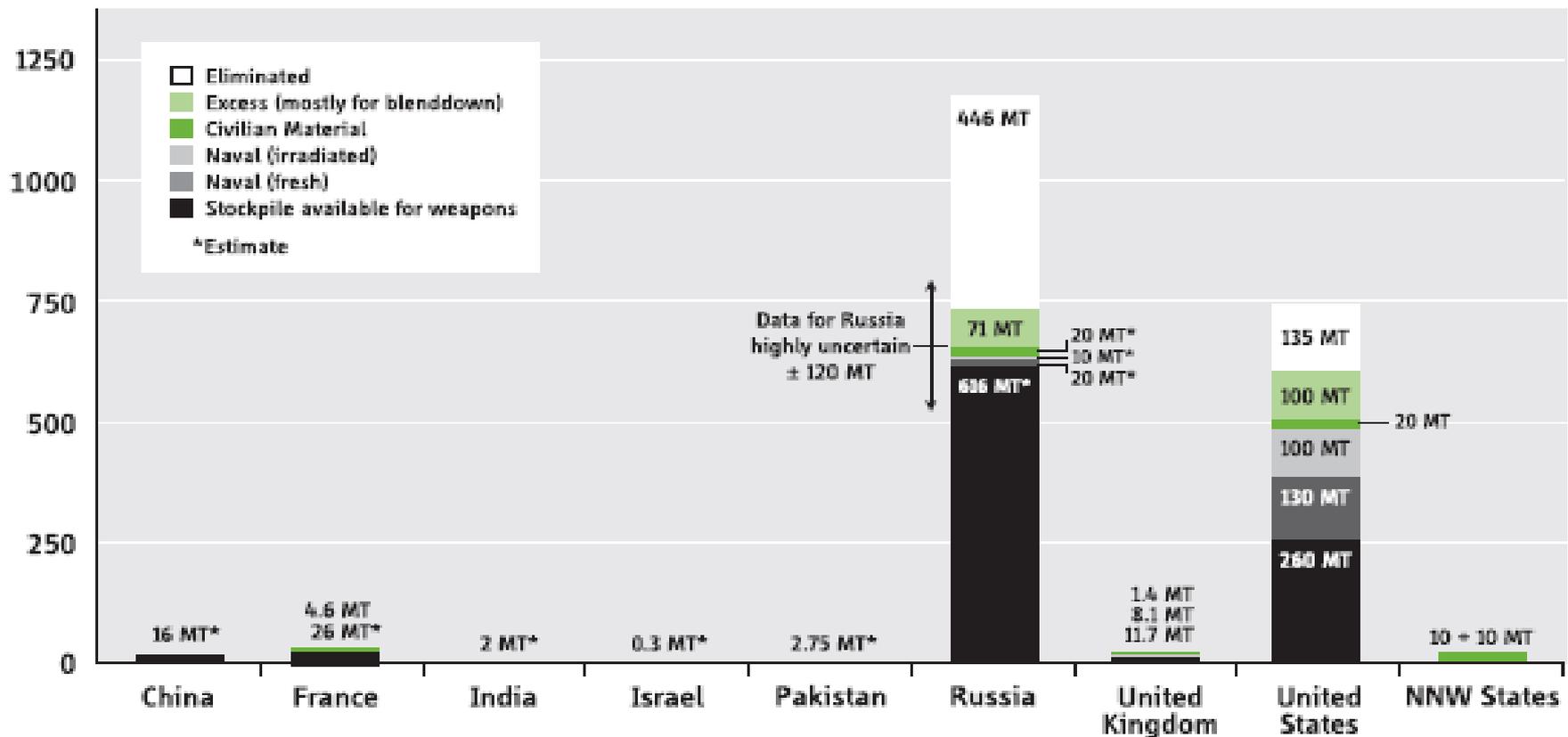
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And

Co-Chair, International Panel on Fissile Materials

- I would like to thank Dr. Ole Reistad and the organizers of this Symposium for inviting me to participate in it.
- Ole had first asked me to speak about the Fissile Material situation in S Asia, but later asked that I also to include a very brief global overview.
- So in the 12 minutes allotted to me, I will attempt the feat of covering two sub-universes, first the World and then S Asia. But I'll discuss only HEU and not Pu
- The data I show will be largely based on the work of the International Panel on Fissile Materials. (Their latest Global Fissile Material Report 2011 available at [www.fissilematerials.org](http://www.fissilematerials.org) )

Metric tons [MT]



IPFM estimate of the current Global Stock of HEU is  
 $1440 \pm 25$  tons

The large uncertainty by 250 tons comes primarily from unavailability of accurate information about Russia in the public domain

# Russian HEU

- Russia has the largest HEU stockpile of any state. Altogether she has produced  $1250 \pm 120$  tons of 90% enriched HEU and another 220 tons with less U-235 content.
- Of this, About 700 tons of HEU has been consumed in naval and other reactor fuel, in plutonium and tritium production reactors, nuclear weapon tests, down-blending ,waste, etc ,
- Leaving behind a current HEU stockpile of an estimated  $737 \pm 120$  tons by late 2011.

# United States HEU

- The total U.S. HEU stockpile is estimated as 610 tons, as of mid-2011.
- In 2006, the United States declared that, as of September 2004, a total of about 690 tons of HEU remained from the 850 tons of HEU it had produced or acquired since 1945
- The stockpile is declining because of the continuing blend-down of 210 tons of HEU declared as excess to military requirements.
- As of May 2011, about 135 tons of HEU had been sent for down-blending, of which 123 tons has already been processed and another 12 tons are to be processed by 2013.
- The U.S. HEU down-blend rate is now about 3–4 tons per year, down from about 10 tons per year reached previously. Down-blending of all the declared excess HEU in the US is currently scheduled to take at least until 2050

# Repatriation

## Taken from NTI's "Past and Current Civilian HEU Reduction Efforts" July 2011

Country	Amount of HEU, kg	Date of Removal
<b>Yugoslavia (Serbia)</b>	<b>48</b>	<b>2002</b>
<b>Romania</b>	<b>14</b>	<b>2003</b>
<b>Bulgaria</b>	<b>17</b>	<b>2003</b>
<b>Libya</b>	<b>17</b>	<b>2003</b>
<b>Czech Republic</b>	<b>6</b>	<b>2004</b>
<b>Uzbekistan</b>	<b>3</b>	<b>2004</b>
<b>Latvia</b>	<b>3</b>	<b>2005</b>
<b>Czech Republic</b>	<b>14</b>	<b>2005</b>
<b>Uzbekistan</b>	<b>63 (spent fuel)</b>	<b>2006</b>
<b>Libya</b>	<b>3</b>	<b>2006</b>
<b>Poland</b>	<b>40</b>	<b>2006</b>
<b>Germany</b>	<b>268</b>	<b>2006</b>
<b>Poland</b>	<b>8.8</b>	<b>2007</b>
<b>Vietnam</b>	<b>4.5</b>	<b>2007</b>
<b>Czech Republic</b>	<b>80 (spent fuel)</b>	<b>2007</b>
<b>Latvia</b>	<b>14.4 (spent fuel)</b>	<b>2008</b>
<b>Bulgaria</b>	<b>6.3 (spent fuel)</b>	<b>2008-2010</b>
<b>Hungary</b>	<b>154.5 (spent fuel)</b>	<b>2008</b>
<b>Kazakhstan</b>	<b>73.7 (spent fuel)</b>	<b>2008-2009</b>
<b>Hungary</b>	<b>155 (spent fuel)</b>	<b>2008</b>
<b>Romania</b>	<b>53.7 (incl. 23.7 spent fuel)</b>	<b>2009</b>
<b>Libya</b>	<b>5 (spent fuel)</b>	<b>2009</b>
<b>Poland</b>	<b>450 (spent fuel)</b>	<b>2009-2010</b>
<b>Czech Republic</b>	<b>n/a (fresh fuel)</b>	<b>2010</b>
<b>Ukraine</b>	<b>106 (incl. 56 of spent fuel)</b>	<b>2010</b>
<b>Poland</b>	<b>41 (spent fuel)</b>	<b>2010</b>

# Down Blending

## "Megatons to Megawatts" program

- As of the end of September 2011, Russia had blended down to LEU a total of 433 tons of the 500 tons of excess weapon-grade HEU it had agreed to sell to the United States by 2013 for use in light-water reactor fuel.
- In the previous 12 months, Russia blended down about 33 tons of HEU. The down blending of a further 67 tons will complete the agreement
- There are no proposals to extend the US-Russia HEU arrangement after the current deal ends in 2013.

# Global Stocks of civilian HEU

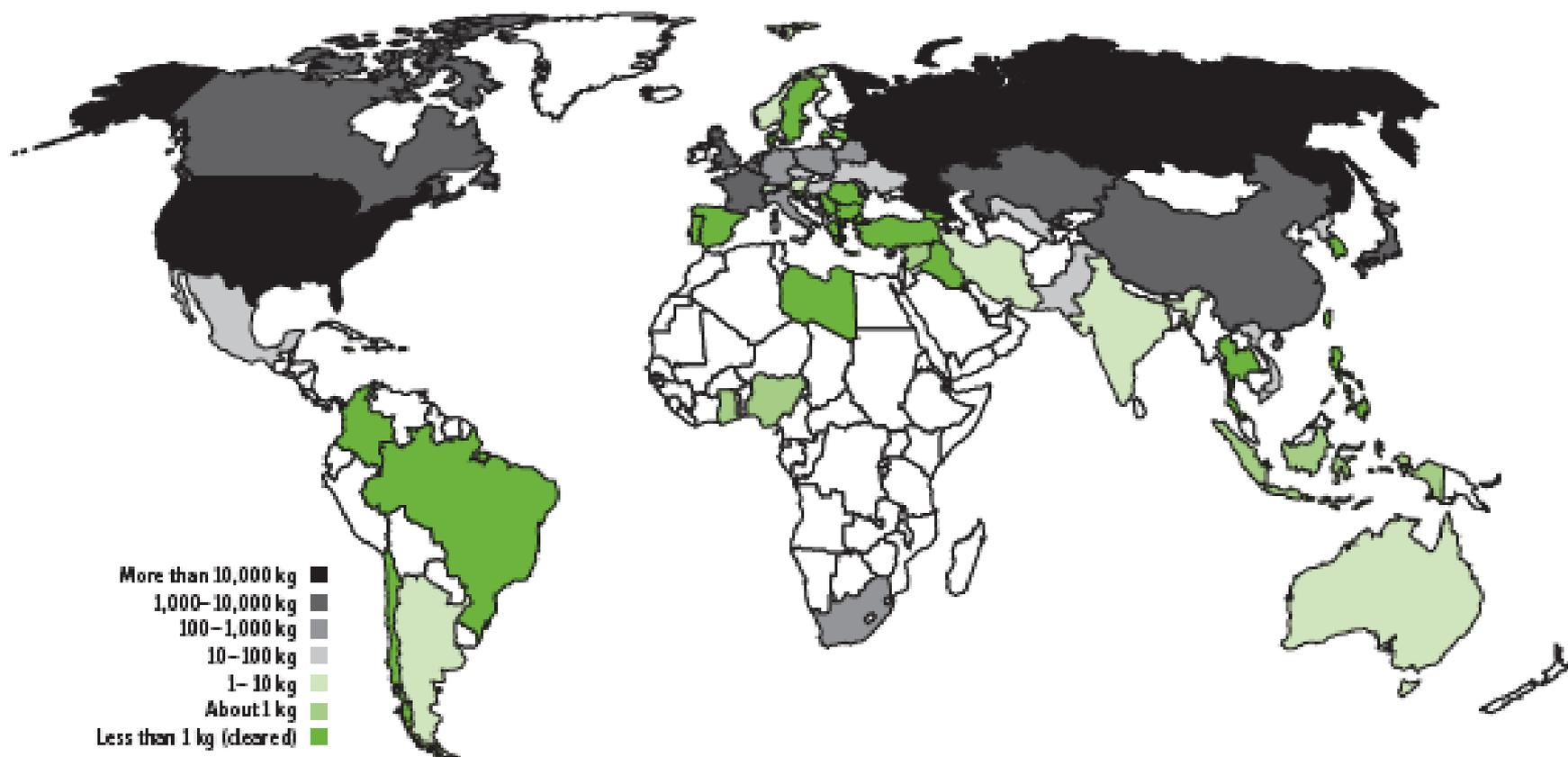


Figure 3. Distribution of civilian HEU worldwide as of 2011. There are still more than 50 sites in about 30 countries where the material can be found in

significant quantities, at operational or shut down, but not yet decommissioned HEU-fueled reactors.

	Russia and NIS	China	Europe	United States	Other	Total
Critical assemblies	36	1	4	5	2	48
Pulsed reactors	16	0	3	3	0	22
Steady-state reactors (< 0.25 MW)	2	3	4	1	11	21
Steady-state reactors (0.26 – 1 MW)	1	0	0	0	0	1
Steady-state reactors (1.1 – 2 MW)	0	0	0	0	0	0
Steady-state reactors (2.1 – 10 MW)	6	0	0	2	1	9
Steady-state reactors (> 10 MW)	9	0	7	4	0	20
In nuclear powered civilian vessels	11	0	0	0	0	11
<b>Total</b>	<b>81</b>	<b>4</b>	<b>18</b>	<b>15</b>	<b>14</b>	<b>132</b>

**Table 1.2. Civilian HEU-fueled reactors worldwide, 2010.<sup>47</sup>** The table does not include military naval reactors.

# Summary: The remaining challenge

(a rough count)

Slide by Courtesy of Frank von Hippel

	Critical Assemblies	Pulsed	Steady-state (MWt)						Naval (including icebreakers)	Total
			≤0.25	0.25-2	2.1-10	10.1-250 (+targets)	Isotope-Prod.	Breeders		
Russia &NIS	≈37	≈22	2	2	4	5	2	2	≈75	≈151
China	1	-	2	0	0	0	0	1	0	≈4
Europe	4	≈2	4	0	2	4 (+1)	0	0	13	≈29
USA	≈5	0	1	1	2	3	0	0	104	≈116
Others	3	0	11	1	2	0 (+1)	0	0	1	≈18
Total	≈51	≈24	20	4	10	12 (+2)	2	3	≈193	≈319

Adapted and updated from Ole Reistad and Styrkaar Hustveit “HEU Fuel Cycle Inventories and Progress on Global Minimization, *Nonproliferation Review*, July 2008

# Why South Asia

- India and Pakistan are the two significant nuclear powers that are known to continue to produce fissile materials. The P5 (seem to) have stopped.

# Indian HEU

- A centrifuge plant has been operating at Rattehalli in southern India since 1990. Assuming enrichment of 30%, India is estimated to have had a stockpile of **2.0 ± 0.8 tons** of HEU by start of 2012.
- Current capacity can produce annually, 500 kg of 30% HEU, or 200 kg of 45% HEU, both assuming 0.3% tails
- [ India also been producing Pu, with a current (2012) stock of 350-700 kg of WGr Pu (**70-140 warheads**) and 3.8-4.6 tons of RGrPu by the end of 2011 ].

# Pakistan's HEU and Uranium constraints

- Pakistan is believed to be mining 40 tons of Natural U annually as of now (The Red Book). But its three Pu producing reactors Khushab 1,2 and 3 will consume almost all of the 40 tons.
- Therefore the rate of HEU production at its centrifuges will suffer from lack of feed, unless new Uranium mines yield significant amounts or they re-use depleted U tails (Note: Even if they get a nuclear Deal, the U so imported will be safeguarded.)
- The current stock of HEU is  $2.7 \pm 1$  tons

# FMCT

- Officially, India has supported a fissile material control regime in principle for a long time.
- This was reiterated by the Indian PM in the Parliament when he said “...We are also committed to negotiate a Fissile Material Cut-off Treaty ..in the Conference on Disarmament. ...”
- But he went on to qualify this with “..subject to it meeting our national security interests.”
- It is clear from the negotiations during the Indo-US Deal and the continuing production of WGrPu, that India feels this requirement has not yet been met.
- India would not be ready to place a voluntary moratorium on FM production right now, let alone sign an FMCT if it were offered today.

# Pak position on FMCT

- Pakistan, like India, would also not want to sign a n FMCT. Its main stated concern at the CD was the asymmetry in existing stocks of FM, presumably referring to India's RGrPu.
- For some time it was content , with a little help from the Chinese, to stall negotiations at the CD in Geneva on procedural counts.
- But a couple of years ago Pakistan decided to explicitly oppose FMCT in principle . This was a surprise, at least to me.
- Possibly this may be a negotiating strategy for something larger, such as a nuclear Deal.
- Attempts are going on the initiate FMCT discussions outside the CD, but I am not privy to how well that initiative is going. As with many other things, the US involvement with Pakistan on the war in Afghanistan casts its shadow on this issue as well.

# The Future ?

- Once India is convinced that it has enough warheads and a back-up stockpile of fissile material for its declared doctrine of minimum deterrence, one can hope that it will be willing, like the NPT nuclear-weapon states, to stop further production.
- The problem lies with their deciding how much is enough.
- I have been arguing for long, in quantitative terms , that what they already have is more than enough for credible minimal deterrence. As of now this view has no takers.
- But little by little, the mainstream view of responsible strategists is coming closer to this view.
- So I continue to harbor hopes that FM production in India will stop in the not too distant future
- And that Pak may follow suit
- Such optimism can be spoilt by development of Battlefield nukes or Ballistic Missile Defense in the subcontinent

Thank You