A Note to the CIPM from Ian Mills, President of the CCU October 2009.
Thoughts about the timing of the change from the Current SI to the New SI

1. The proposal is to change the definition of the kilogram, ampere, kelvin and mole so that they are referenced to the values of the fundamental constants *h*, *e*, *k*, and N_A. These are a set of changes that support each other, and should be made together. The resulting improvement in our knowledge of all the fundamental constants is shown in the attached table. For many constants the uncertainties are reduced to zero, and for almost all others they are reduced by an order of magnitude.

2. The change in the definition of the kilogram to a new definition linked to a fixed value of *h* would give us a reference for the definition that is a true invariant of nature. The current definition is referenced to the mass of the international prototype (the IPK) which we know to be drifting in mass. We do not know how much it has drifted over the last 100 years, but it could possibly be as much as a part in 10^7, i.e. 100 μg. The uncertainty in the mass of the IPK is also reproduced in the current definitions of the ampere, kelvin and mole. The electricity community will immediately benefit from the proposed changes by having fixed values of *h* and *e* because the Josephson and von Klitzing constants will then be exactly known. The thermometry community will also benefit from the flexibility that the fixed value for *k* in the new definition of the kelvin will bring to primary thermometry. There is a broad consensus in the chemical community of the advantages in fixing N_A, and the CCPR very recently welcomed the proposed re-wording of the definition of the candela.

3. The CIPM owes it to the metrology community, and to all of science and technology, to produce a solution to the problem posed by the present definition of the kilogram as soon as is practicably possible.

4. It is sometimes claimed that we should wait for the results of further experiments to improve our knowledge of *h*, *e*, *k*, and N_A before changing the definitions.

   However this seems to be an argument for never making any change. History has shown that the CODATA best-estimates of the values of the fundamental constants are forever improving: the uncertainties have mostly been reduced by roughly an order of magnitude every ten or fifteen years for the past 60 years. When new best-estimates of the constants are published the uncertainties are now almost invariably reduced and the changes in the values are not at an unacceptable level. One can say that the CODATA best-estimates of the values of the fundamental constants have been demonstrated to be robust.

   The conclusion seems to be that if there is a valid argument for making a change, it is best not to wait but to proceed with the change. To wait is to postpone or delay new developments in the field; to proceed is to stimulate and encourage new experimental work. We should recognize that the experiments to evaluate the constants will still be required – more than ever – once the change has been made, because they will become the experiments to realize the new definitions.

We need the stimulus now that the new definitions will bring.

5. "Science, including technology, was the dominant culture of the 20th century, and seems set to dominate the 21st even more. However, scientific advances are only made by intellectual endeavor, as are advances in the arts. These cultural aspects are continually overlooked as society exploits scientific knowledge without understanding it. This results not only in the injudicious use of the fruits of scientific advances, but also the misapplication of resources for research."
This quotation is from Harry Kroto, Nobel Laureate 1995.

We might add to this quotation that the importance of metrology, and our ability to make measurements accurately and reliably, with known uncertainty, is moving ever higher in the agenda of our lives. All of us are aware of the extent to which we depend on measurements in our modern technology-based society. It is for the CIPM to lead the way in ensuring that our ability to make these measurements is not restricted by the weaknesses in the definitions of our units.

The table below shows relative standard uncertainties for a selection of fundamental constants, for both the Current SI and the New SI (shown in red), multiplied by 10^8 (i.e. in parts per hundred million). These numbers are based on the 2006 CODATA least squares adjustment, which is the most recent available; the numbers from the 2010 adjustment are expected to be smaller, in several cases by a factor of almost ½ (e.g. 0.14 will become 0.07, 0.068 will become 0.04 and 0.034 will become 0.02).

constant	current SI	new SI
$m(\mathcal{K})$	0	**5.0**
h	5.0	**0**
e	2.5	**0**
k_B	170	**0**
N_A	5.0	**0**
R	170	**0**
F	2.5	**0**
σ	700	**0**
m_e	5.0	**0.14**
m_u	5.0	**0.14**
$m(^{12}C)$	5.0	**0.14**
$M(^{12}C)$	0	**0.14**

constant	current SI	new SI
α	0.068	**0.068**
K_J	2.5	**0**
R_K	0.068	**0**
μ_0	0	**0.068**
ε_0	0	**0.068**
Z_0	0	**0.068**
q_P	2.5	**0.034**
J↔kg	0	**0**
J↔m^{-1}	5.0	**0**
J↔Hz	5.0	**0**
J↔K	170	**0**
J↔eV	2.5	**0**