Report of the visit of the Scientific Advice Mechanism (SAM) High Level Group of Scientific Advisors (HLG) to the Joint Research Centre (JRC)

Ispra, 4 March 2016

1. Introduction

A fact-finding visit of the SAM High Level Group to the JRC in Ispra (Italy) was organized on 4 March. **Henrik Wegener** and **Julia Slingo** participated (the latter via videolink); **Pearl Dykstra** could not be present but nominated Erik Van Der Linden to participate (via videolink) on her behalf. The main objective of the visit was to collect evidence on the two topics currently tackled by the SAM: 1) CO_2 emissions and laboratory testing, and 2) cybersecurity.

DG RTD Deputy Director-General W. Burtscher, the Head of the SAM Unit J. Klumpers, the secretary of the SAM HLG Jose Jimenez Mingo and Christian Kurrer from the SAM Unit participated in the visit. On the JRC side, the Director-General V. Šucha, two Directors (S. Lechner of the Institute for the Protection and Security of the Citizen and Giovanni de Santi of the Institute for Energy and Transport), the Chair of the JRC Board of Governors W. Mönig, the Unit Heads and selected scientist of the relevant JRC units took part.

In Brussels, a videolink was established with relevant colleagues of the SAM unit and representatives of DG GROW, DG CLIMA, DG MOVE and DG CNECT.

The visit featured presentations on JRC activities related to the two SAM topics, discussions on related evidence and open issues, as well as a tour of the JRC's Vehicle Emissions Laboratory and Laboratory for Interoperability of E-vehicles and Smart Grids. The summaries of the main outcome of the visit are provided hereafter in sections 2 and 3 for CO_2 emissions and cybersecurity, respectively.

It must be noted that these two topics are in different stages of development. While the CO_2 emission file is relatively well advanced and clearly focused, the cybersecurity one is still in its initial phase. This is mainly due to a relatively late adoption of the cybersecurity scoping paper and its wide-ranging nature. In addition, while the JRC is a reference centre for CO_2 emission and car testing, its activities in cybersecurity are relatively limited. This context explains why the two topics could not be addressed at the visit with the same comprehensiveness. The corresponding summaries therefore differ.

Furthermore, in order to make the most of the visit, specific questions (mostly based on the scoping papers and the preliminary findings of the literature review) were delivered beforehand by the SAM HLG to the JRC. The visit enabled to collect precise evidence (summarised in section 2) for the questions related to CO_2 emissions. No precise replies to the cybersecurity questions were collected for the reasons stated above.

2. Closing the gap between light duty vehicle real-world CO2 emissions and laboratory testing

Currently, CO2 emissions are measured in a laboratory according to the New European Driving Cycle (NEDC). The Commission is aware of the significant divergence between current test cycle measurements and actual emissions in real world driving. These shortcomings will be addressed with the introduction of a new testing procedure, the Worldwide Harmonised Light-Duty Test Procedure (WLTP), as agreed in the framework of UNECE and requested by Regulation 333/2014 on CO2 emissions from cars. The new test procedure should ensure that the measurements better reflect emissions in real driving conditions and that there is less flexibility in carrying out the tests. The Commission is working towards September 2017 as a target date for WLTP to be in place, coinciding with the timing for the entry into force of real drive emissions testing for NOx.

The present document provides the answers given by the Joint Research Centre (JRC) to a set of questions that the SAM HLG has identified as relevant in order to address the two specific questions identified in the approved scoping paper for the topic "Closing the gap between light duty vehicle real-world CO2 emissions and laboratory testing":

- What is the European and world-wide scientific basis for improving the measurement of light vehicle CO2 emissions and fuel consumption in order to produce values closer to average real-world data?

- Which approaches might be considered, what are their strengths and weaknesses, also in terms of reliability and transparency, and what additional scientific and analytical work would be needed?

The document is based on the discussions and presentation done by JRC during the fact-finding visit.

Q1. What is the existing gap (average) in CO2 measurements between laboratory-based type approval tests and real on-road emissions?

The "gap" issue ("real-world" versus manufacturers' type-approval CO2 emissions) was identified already in 2005, namely in the AIE Report 2005 "Making cars more fuel flexible – Technology for real improvements on the road". This document already reports a gap between light-duty vehicle fuel economy as measured on official certification tests in OECD countries and the actual on-road fuel economy. The report estimated a gap of the order of 10 to 15 %.

Several researchers (see e.g., ECMT 2005[1]) have tried to quantify the gap based on various approaches (emissions inventories, vehicle simulations, fuel sales based estimations).

A common finding in several research works is that, in Europe, the divergence of the real vs. certified CO2 emissions / fuel consumption has increased from year to year, with an

[1] http://internationaltransportforum.org/pub/pdf/05Cars.pdf

accelerated widening of the gap following the adoption of the current CO2 emission limits at EU level ten years ago. This fact has raised concerns especially among various NGOs.

JRC has extensively worked in this area and estimates real world CO2 emissions and fuel consumption to be on average 25-30% (2013 data) higher than officially reported.

JRC has also extensively worked in understanding the origin of the gap and divided its possible root causes in two groups, related to the testing environment and real driving:

1) Origin Test

- Test definition & boundaries (fixed temperature, driving cycle, no auxiliaries)
- Test elasticities (e.g. fully charged battery, optimal tyres, no side mirrors)
- Malevolent acts? (e.g. VW case)

2) Origin "Reality"

- Vehicle (e.g. different mass, tyres, auxiliaries, maintenance)
- Driver (e.g. driving behaviour and habits)
- Environment (e.g. weather, traffic, road morphology)

JRC has presented a very interesting table summarizing the contribution of the different factors to the value of the gap based on published literature.

Q2. What is the expected gap in CO2 (average) emissions vs. real data under WLTC? What is the expected evolution over time taking into account possible test cycle flexibilities, in- use factors, etc…?

Conscious of the limitations of the NEDC, already in the EC Regulation 443/2009 and 510/2011 (setting the CO2 targets for passenger cars PC and Light Commercial Vehicles LCV) the Commission set the political objective to implement a new and more realistic test cycle by 2014.

In June 2009, in fact, at the UNECE level a road map for the development of a new test procedure had already been presented. The work for the development of the Worldwide harmonized Light vehicles Test Procedures (WLTP) had already started.

The objective was to design:

- a more realistic test-cycle
- a more stringent test procedure (less prone than the NEDC to interpretations and flexibilities)

WLTP covers some aspects in a more realistic way. Moreover, the uncertainties related with the test present in NEDC are to be addressed by WLTP, such as:

- Test definitions more realistic (e.g. continuous mass)
- Known elasticities eliminated

JRC is confident that WLTC is much closer to reality and has shown a table with the list of factors that were taken into consideration or improved in the WLTC when compared with NEDC. JRC has shown a graph showing the range of CO2 emissions (g/km) to be 163 (reality) 150 – 138 (WLTP) 137-128 (NEDC) and 123 (certification value).

It is necessary to remind though that some emission-relevant factors – such as the use of air conditioning systems – are not reflected in the WLTP either. Also environmental conditions vary considerably across Europe and the question is how to account for these (the US EPA is using correction factors to reflect these).

From the analyses carried out by JRC, they concluded in this respect that:

- With WLTP the gap will reduce with respect to the NEDC case
- A gap between laboratory and real driving emissions is likely to remain
- The gap seems to be unavoidable due to the very nature of the laboratory tests if compared to the variability of the real-life conditions.

But it is important to understand if the gap constitutes a problem.

- From a consumer perspective, the gap is a problem if it is different for different vehicles so that it can mislead the purchasing choices. Otherwise it is almost irrelevant.
- From the regulatory perspective, the gap is a problem if it widens over time, as it would indicate that CO2 emission targets are not being achieved in reality.

Q3. What are the possible solutions to reduce the gap under WLTP (e.g. introduction of a "Not to exceed" limit)?

The WLTP represents a considerable step forward in addressing the problem. Whether it will suffice alone or additional measures are necessary is difficult to be assessed before its actual introduction.

A mechanism to monitor the evolution of the gap can be considered by the EC. Potential options:

- Compare CO2 values according to WLTP and the CO2 values obtained in real driving tests and check whether the average difference tends to vary for a certain manufacturer.
- Use CO2MPAS (a model developed by JRC), calibrated with the results of a real driving emissions test to verify and/or adjust the type-approval value.
- Record and monitor cumulative fuel consumption in vehicles' on-board systems after any mandatory service and check that the average difference with the WLTP values per each manufacturer does not increase.

Q4. Can the correlation model developed by JRC be used to calculate expected gaps under WLTC on the basis of the existing gap under NEDC?

WLTP will have a phasing-in period 2017-2020 (industry needs a minimum lead time of 5 years to adapt). During this period, the legally binding targets are still based on the NEDC, which requires the WLTP-based CO2 emissions (measured at type-approval) to be translated into the equivalent NEDC-based ones, in order to assess the compliance with existing CO2 emission targets.

To perform the conversion of WLTP-based CO2 emissions to NEDC-based ones, JRC has developed CO2MPAS, which is a backward-looking CO2 & fuel-consumption simulator for Light-Duty Vehicles (cars and vans). CO2MPAS is a powerful tool specially crafted to back-translate consumption figures from WLTP cycles into NEDC ones. A solution that should be further explored is the use of CO2MPAS calibrated with the results from real driving emissions tests to create a procedure to close the gap for the WLTC tests (this suggestion was not clearly stated by the JRC).

Q5: What are the expected benefits in terms of closing the gap between CO2 emissions measured and declared and real CO2 emissions?

The EC announced (27 January 2016) a major overhaul of the so-called EU type approval framework (see http://europa.eu/rapid/press-release_IP-16-167_en.htm). The draft Regulation has been sent to the European Parliament and Council for adoption. Once adopted, it will be directly applicable. It will repeal and replace Directive 2007/46/EC.

Under current rules, national authorities are solely responsible for certifying that a vehicle meets all requirements to be placed on the market and for policing manufacturers' compliance with EU law.

The proposal for a Regulation will help to achieve three objectives:

- Reinforce the independence and quality of testing that allows a car to be placed on the market.

- Introduce an effective market surveillance system to control the conformity of cars already in circulation.

- Reinforce the type approval system with greater European oversight.

According to the proposed legislation, the Commission will have the power to suspend, restrict or withdraw the designation of technical services that are underperforming and too lax in applying the rules. In the future the Commission will be able to carry out ex-post verification testing (through its Joint Research Centre) and, if needed, initiate recalls. By allowing the Commission to impose financial penalties, the proposal will deter manufacturers and technical services from allowing non-compliant vehicles onto the market. The Commission will also chair an Enforcement Forum which will develop common compliance

verification strategies with Member States and organise joint audits of technical services and peer reviews of type-approval authorities.

This proposal for a Regulation on the approval and market surveillance of motor vehicles complements efforts to introduce more robust emissions testing (Real Driving Emissions testing).

Q6: What is the role of JRC?

The JRC has played a key role in the development of WLTP and of other standards for emissions testing, including real driving emissions testing. According to the proposed legislation, the Joint Research Centre will be in charge of carrying out compliance and conformity checks for the Commission. It will be the technical arm of the supervisory system of the Commission and will carry out selected regulatory emissions testing in the laboratory and on the road. This will allow the Commission to make an informed and unbiased judgement on any non-compliance.

Q7. How can (or cannot) the new Real driving emissions (RDE) approach adopted for regulated pollutants be useful to reduce the gap in the case of CO2 emissions?

Rather than putting the vehicle in a laboratory, the laboratory can be put in the vehicle, e.g. using Portable Emission Measurement Systems (PEMS).

Strengths of RDE for CO2:

- CO2 data recorded from actual on-road driving
- RDE tests of up to 2h generate a large data pool
- Potential coverage of a wide range of conditions
- Detection of emission anomalies
- Robustness against defeat strategies

Limitations of RDE for CO2:

- Potentially biased trip design deviating from average driving
- Biases in trip duration, driving conditions, vehicle load
- Driving referenced to WLTP conditions
- Low repeatability of CO2 measurements
- Measurement uncertainty higher than under laboratory conditions

Q8. How can the CO2 measurements taken under an RDE procedure be useful to reduce the CO2 gap?

RDE provides some first-order estimate of real-world CO2 emissions. The following aspects should be considered:

- RDE for market surveillance and as low-cost verification procedure
- Adaptations needed to use RDE as CO2 certification procedure
- Elements of RDE test procedure can be used to design on-road CO2 emissions tests
- Data pool from RDE tests can be used
- From the data pool RDE events could be selected to re-construct desired average driving patterns and CO2 emissions
- Use of fuel consumption meters instead of PEMS improves measurements
- Data source for CO2 modelling

Q9. What are the scientific reasons to support (or not) the introduction of a similar RDE approach in the Post 2020 emissions package for CO2?

Julia Slingo pointed out that the work should not lose perspective and we should keep in mind that the ultimate goal is the decarbonisation and the improvement of the technology. Moreover the CO2 issue is of a complete different nature than the NOx and particles issue and the way regulation deals with CO2, NOx and particles should reflect such differences (indeed, it does already as NOx/particles targets apply to individual vehicles whereas CO2 targets apply to entire car fleets).

Q10. What are the possibilities from a scientific point of view to use real consumption of fuel as an indicator of real emissions? I.e. measuring and registering the fuel consumption of a vehicle over its lifetime in a non-erasable manner to obtain information on the fuel consumption of individual vehicle types, together with the mileage driven, that could be regularly and systematically read out for the entire fleet at the mandatory periodic vehicle inspection under European and national law.

There is no technical reason not to use fuel consumption as a proxy for CO2 emissions. Actually the data from fuel consumption, data from various sensors in the vehicle, RDE data for CO2 using PEMS and making use of a simulator such as CO2MPAS will probably constitute a powerful answer to calibrate the gap still existing between the WLTC tests results and the real life. Traditionally the industrial sector has opposed the use of fuel consumption data as this solution would require to standardise and certify fuel consumption meters (currently each car manufacturer uses its own technology) and to collect anonymised data (which raises the question how this data would be communicated and how privacy would be ensured). In spite of that, JRC is convinced that this is a way to explore.

Q11. Which are the differences between the WLTP and test cycles used in America and Asia regarding CO2 emission measurements and the related gaps between laboratory and real drive emissions? How do regulatory authorities in America and Asia tackle the problem?

One important difference is related with the trust of the citizens in the process. This is the case, for instance, with the US EPA which is generally trusted by citizens, whereas in Europe test approval is mainly done by mandated private companies, without any ex-post control. In the US and Japan the post validation is mandatory while in Europe it is not (here it is done on an ad-hoc basis by automotive journals or automobile clubs etc.). The EC hopes to change this aspect with the regulation under preparation.

JRC is suggesting that, in addition to better consumer information and the implementation of WLTP in 2017, the European Commission should consider the possibility of establish a kind of European Type Approval Authority to ensure tests are performed consistently and independently.

Moreover, with the WLTP there is for the first time a test cycle with the potential to be implemented worldwide. EU and Japan will use it and most probably South Korea and India. There is less certainty with US and China.

Further steps:

JRC will send us a document with the answers to the questions formulated by the HLG. JRC offered their help for contacts with stakeholders and identification of experts.

3. Cybersecurity

a. Summary of the discussions

The discussions highlighted the willingness of the JRC to support the SAM on this topic, taking into account that JRC research in this area is relatively limited.

It also highlighted the complexity and fragmented nature of the topic. It was concluded that further steps are needed to increase clarity regarding the "big questions" for scientific advice in this area, on the basis of the scoping paper. While all the questions mentioned in this document are important and cannot be "prioritised" at this stage, further clarification of the policy drives would be helpful. The next steps towards the elaboration of a scientific opinion will therefore address this need.

From the interventions of the JRC representatives, the following messages were identified:

- The **prioritization of the challenges presented in the scoping paper is not straightforward**.
- The size of the EU digital market is already significant but needs harmonised rules to flourish, notably by increasing the trust of consumers in ICT equipment and services.

The suppliers of ICT equipment and services are mainly from 3rd countries (particularly the US and China), which may have certain security drawbacks. In order to raise the security level, and the trust of consumer, it would be helpful to define **common minimum security standards for suppliers of hardware and software in the European market**.

- **The dilemma between privacy and security is not purely scientific**. It is also about societal values, in particular trust, which requires transparency, ownership and participation, notably from the citizens.

- Cooperation between the public and private sectors is essential. The setting-up of the future **European Network and Information Security (NIS) Public-Private Partnership**[2] is important. The views of the academia will need to be considered and objectives on certification/labelling, and how to handle threats and vulnerabilities, will have to be included.

- On digital identities, the **existing barriers to the development of a single European digital signature are mainly due to Member States' wish to maintain sovereignty** on the handling of digital identities. These concerns will have to be addressed.

- **Cybersecurity is a multidisciplinary issue** that relies also on soft sciences such as behavioural insights, economics, foresight and horizon scanning. The JRC has an extended expertise in these areas. It has notably published a foresight study "**How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025?**" which in particular analyses "digital factories". There is also the JRC report "**The Macro-economic Impact of e-Commerce in the EU Digital Single Market**"[3] which studies the fragmentation of the Digital Single Market. Moreover, the JRC recently published the report "**Behavioural Insights Applied to Policy – European report 2016**"[4] that provides an overview of practices across 32 European Countries, covering a wealth of policy applications.

b. Proposed next steps

- The consultation of the JRC in order to draw evidence on cybersecurity will continue, as relevant.

- The JRC will be requested to provide further input to the questions prepared for the visit (which may be updated based on the exchanges in Ispra).

c. Summary of JRC's presentations

➢ **Introduction to cybersecurity at the JRC** *(Stephan Lechner, Director of the JRC Institute for the Protection and Security of the Citizen – IPSC)*

[2] https://ec.europa.eu/digital-single-market/node/80873
[3] https://ec.europa.eu/jrc/sites/default/files/JRC98272.pdf
[4] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC100146/kjna27726enn_new.pdf

Working in ICT security since 1989, Dr LECHNER recapped in his presentation different attempts from the past to deal with cybersecurity (e.g. establishment of governmental requirements and international standardisation standards, awareness raising, training) and the problems that these approaches ran into. As the technology became more and more complex, different approaches have been developed, achieving some progress but soon also showing their limitations. He quoted the security expert Bruce SCHNEIER[5] who said that cybersecurity is a process.

In addition, he provided some "food for thought" that is relevant to the approach of the field as described in the SAM scoping paper on cybersecurity*:* 1) cybersecurity is and will stay fragmented, 2) the chain is as weak as the weakest link, 3) technology is a moving target, regulation is slower, 4) security needs to be integrated, not added, 5) cybersecurity is different from the real world security, 6) cybersecurity protects everyone, also criminals, 7) cybersecurity is not only about technology.

- **Cybersecurity activities at the JRC** (*Jean-Pierre Nordvik, IPSC Head of Unit G6 "Digital Citizen Security")*

He presented an overview of the JRC activities in cybersecurity along these focus areas (the details can be found in his presentation; some additional elements are highlighted below):

1. **Encryption**, which is a fundamental and horizontal issue that supports all the other areas.
   - The JRC contributes to the definition of Quantum-Safe Cryptography by supporting the work of a dedicated ETSI (European Telecommunications Standards Institute) working group[6].
   - The JRC contributed to the UK Government Chief Scientific Adviser report on distributed ledger technology[7], by looking at the opportunities for the European energy retail market. Distributed ledger technology is already used by the Estonian government.
   - The JRC supports Europol on the study of innovative ways to enter protected devices and break encryption. It develops in particular new techniques going beyond brutal attacks, such as context-based decryption.
2. **Digital identities (allowing elements and systems to communicate)**
   - The JRC hosts and maintains the Public Key Infrastructure serving the EU "Laissez Passer".
   - It develops applications for the entry/exit of 3rd country nationals in the Schengen areas based on biometrics.
3. **Network security (e.g. internet and the Internet of Things)**

[5] https://www.schneier.com/
[6] http://www.etsi.org/technologies-clusters/technologies/quantum-safe-cryptography
[7] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf

- The JRC contributes to the definition of cyber-exercise with ENISA.

4. **Industry 4.0**

- The JRC develops Best Available Techniques for energy smart metering systems. In transport, it prepares technical specifications, including security mechanisms, for the new smart tachograph. It also develops standards for smart cars security.
- Newly discovered vulnerabilities could be managed at European level to ensure that the systems are fixed to protect citizens, companies and governments, and are not exploited by organised crime, for instance.

5. **Privacy for individuals and citizens**

- The JRC works with DG ENER and DG MOVE on the risks associated with emerging technologies, respectively in the energy and transport sectors.
- It helped assess different policy options regarding how EU personal data are protected by 3rd parties (e.g. EU-US Privacy Shield)

6. **Cybercrime**

- The JRC works with DG HOME on fraud and counterfeiting of virtual currencies (e.g. Bitcoin); citizens using these technologies must be protected.

7. **Kids online protection**

- The JRC developed "Happy Onlife"[8], an interactive game for children and adults aimed at raising awareness of the risks and opportunities of the internet and promoting the best practices online.

[8] https://ec.europa.eu/jrc/en/scientific-tool/happy-onlife-game-raise-awareness-internet-risks-and-opportunities