BETTER POLICIES FOR BETTER LIVES

Scientific Workshop- Grouping of Nanomaterials- Gracious NanoReg2

OECD WPMN EXPERT MEETING ON PHYSICO-CHEMICAL PARAMETERS FRAMEWORK FOR THE RISK ASSESSMENT OF NANOMATERIALS

September 12, 2018

Ken Moss, US EPA

Physico-chemical properties of nanomaterials: why are they so important?

- **Nanomaterial Characterization**
  - More needed than chemical identity alone: particle size distribution, surface area, shape, …

- **Grouping / read-across**
  - To what extent are nanomaterials similar to other nanomaterials
  - To what extent are nanomaterials similar to non-nanoform

OECD Testing Programme of Manufactured Nanomaterials

- Launched in 2007
- Understanding of intrinsic properties of nanomaterials (properties unique to the nanoscale dimension) for appropriate risk evaluation and risk management

  >>> verification of testing methods used for safety testing of NM
- Collaboration between government, industry and academia
- "Sponsors": coordinate the testing for a specific NM
- "Contributors": provide test data and materials to lead and co-Sponsor

OECD Testing Programme of Manufactured Nanomaterials

Priority list of **11 "key nanomaterials"** (based on commercial use):

MWCNTs – SWCNTs – CeO2 – SiO2 – TiO2 – ZnO – Ag – Au – Dendrimers – Fullerenes – Nanoclays

These nanomaterials have been tested for their:

- nanomaterial information/identification;
- physical-chemical properties and material characterisation;
- environmental fate;
- environmental toxicology;
- mammalian toxicology; and
- material safety.

Evaluation of analytical methods

Evaluation of methods for physico-chemical properties

- Using the **test dossiers** of the OECD Testing Programme

- **Expert evaluation** of analytical methods for physico-chemical parameters
  (using standardised questionnaire)

- Summary of evaluations per method/parameter: *Physical-chemical properties of nanomaterials: evaluation of methods applied in the OECD-WPMN testing programme* (www.oecd.org/env/ehs/nanosafety/publications-series-safety-manufactured-nanomaterials.htm, **No. 65**)
- Publication in *Regulatory Toxicology and Pharmacology* (Rasmussen et al. 2018, doi:10.1016/j.yrtph.2017.10.019)

OECD Parameters

		Test methods in dossiers
Chemical composition		XPS, ICP/OES, EDX
Surface chemistry		XPS, EDX, Liquid chromatography
Crystallite size	What they are	XRD
Crystalline phase		XRD, Raman, TEM/SEM
Particle size distribution		CLS, DLS, TEM/SEM, DMA, DOSY-NMR,
Specific surface area		BET, SAXS
Porosity		BET / BJH, Mercury porosimetry
Water solubility / Dispersibility	Where they go	Shake flask, Spectrometry, Filtr.&Centr.
Aggregation/agglomeration		AFM, TEM/SEM, DLS, Turbidity
Zeta potential		ELS, Laser-Doppler
Dustiness		(Small) Rotating Drum, Contin. Drop, Vortex
Redox potential	What they do	Potentiometry, Oxo-Dish
Radical formation potential		EPR/ESR, Potassium Iodide, Benzoic acid
Photocatalytic activity		Degradation methods
Pour density		Not evaluated
Octanol-water partitioning coefficient		Not evaluated

Conclusions of the method evaluation

- Testing Programme mostly used methods that can be used for chemicals *including* NM (not specifically developed for NM)
- Methods available for most of the parameters

  Some have limitations or need specific adjustments:
  - Sample preparation, Conversion of results, Restricted to certain types
- Better suitable methods needed for measuring
  - Reactivity, Surface chemistry, Dissolution rate and aggregation state in relevant media
- Lack of **standardized** methods
- Evaluation often hampered by limited reporting
  - lack of details on sample properties and test setup

    >> recommendations on minimal reporting requirements helpful, e.g. OECD Harmonised Templates, NANoREG, etc.

Next steps

- **Decision Framework for the Physicochemical Characterisation of Manufactured Nanomaterials**
  What to measure when, and which method to choose
  Lead Sponsors: United States & Netherlands

- **Guiding Principles for Measurements and Reporting for Nanomaterials**
  How to measure, and what to report
  Lead Sponsor: BIAC

Physico-Chemical Framework Objectives

- Develop framework to identify appropriate methods for characterising physico-chemical endpoints
  - for specific types of nanomaterials (molecular identity)
  - for different risk assessment purposes (screening/robust risk assessments).

- Identify methods NOT appropriate (for a NM/type of assessment)

- Develop decision trees that identify, based on a specific type of NM and type of assessment, the appropriate/not appropriate method(s) to be used/ not used in determining a given physico-chemical parameter

Interlinkages between projects

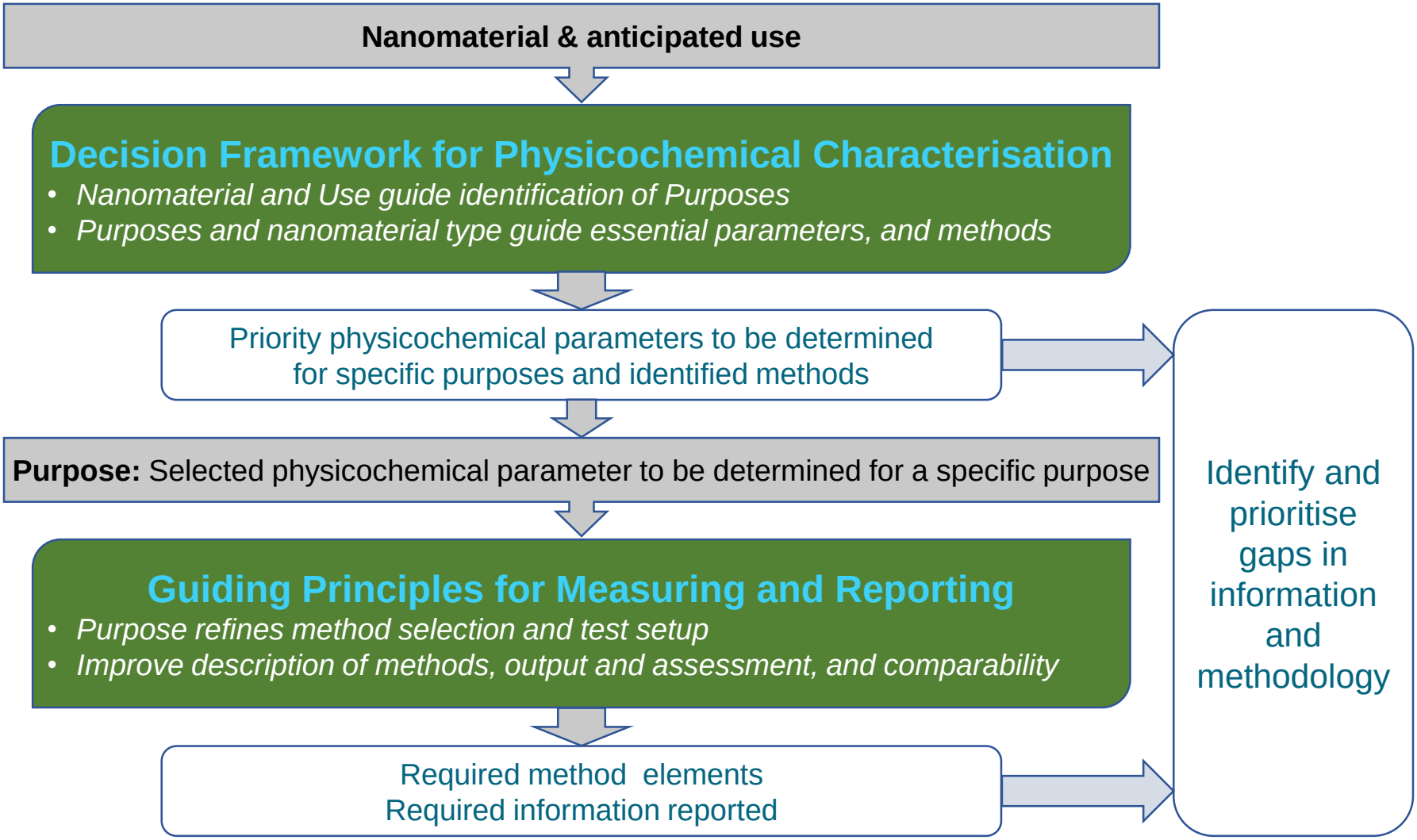
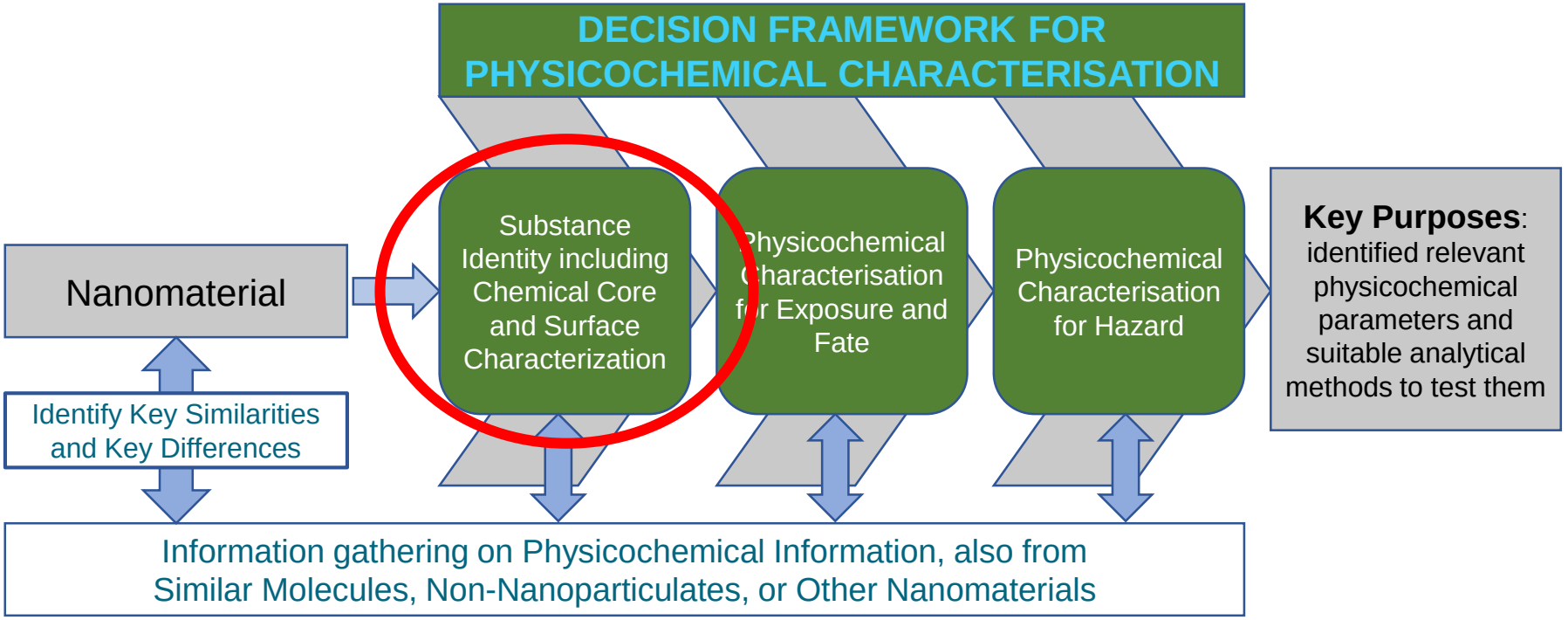


Figure 1. Physical-Chemical Decision Framework to Inform Decisions for Risk Assessment.

Decision Framework



Comparison with existing information in order to:

- Identify important parameters
- Identify purpose
- Read-across and/or group

Decision Tree for *Physico-Chemical Decision Framework to Inform Decisions for Risk Assessment:* Substance Identification and Information Gathering

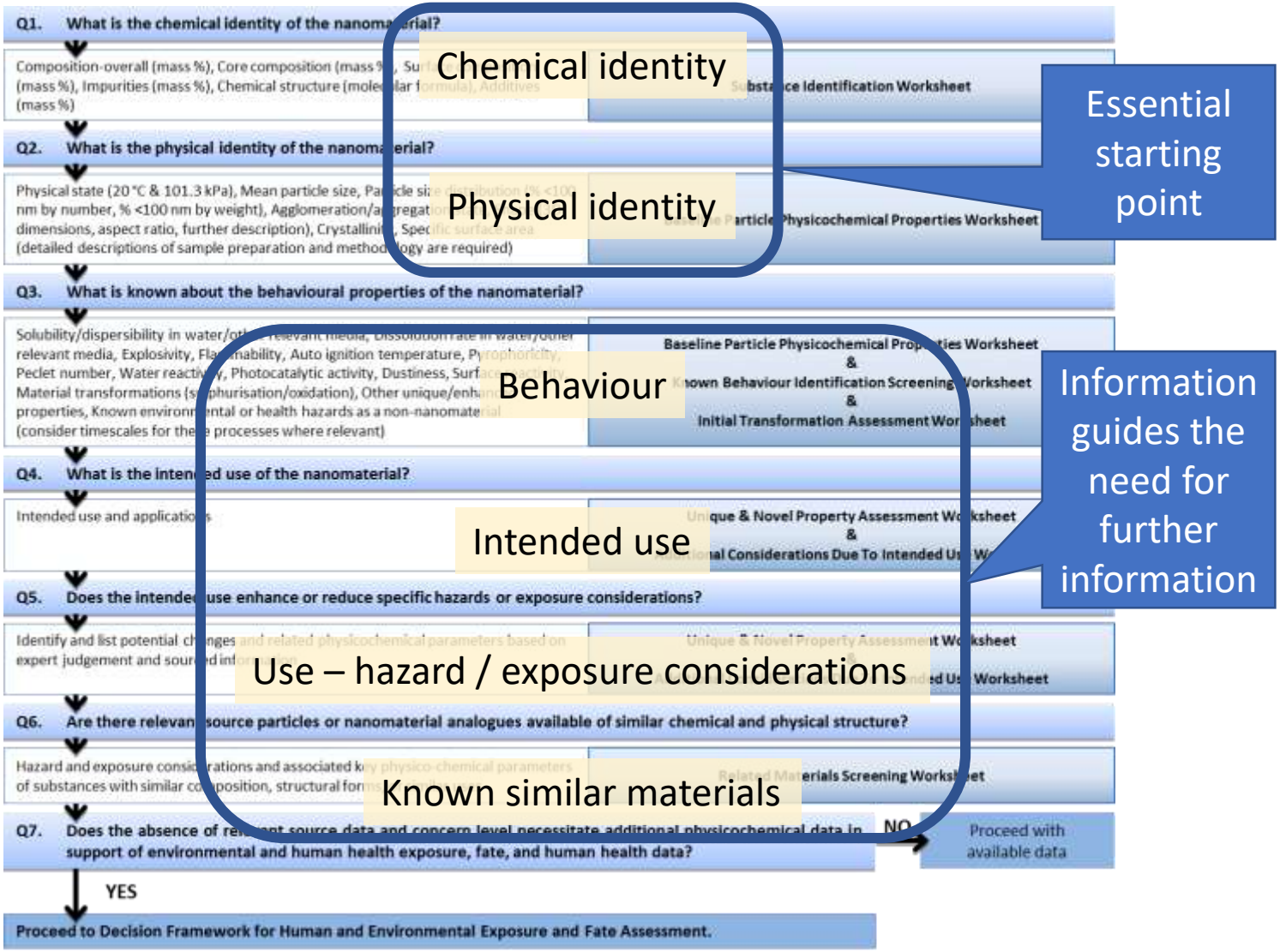


Table 1. Workshop Thought Starter.

Interlinkages between projects

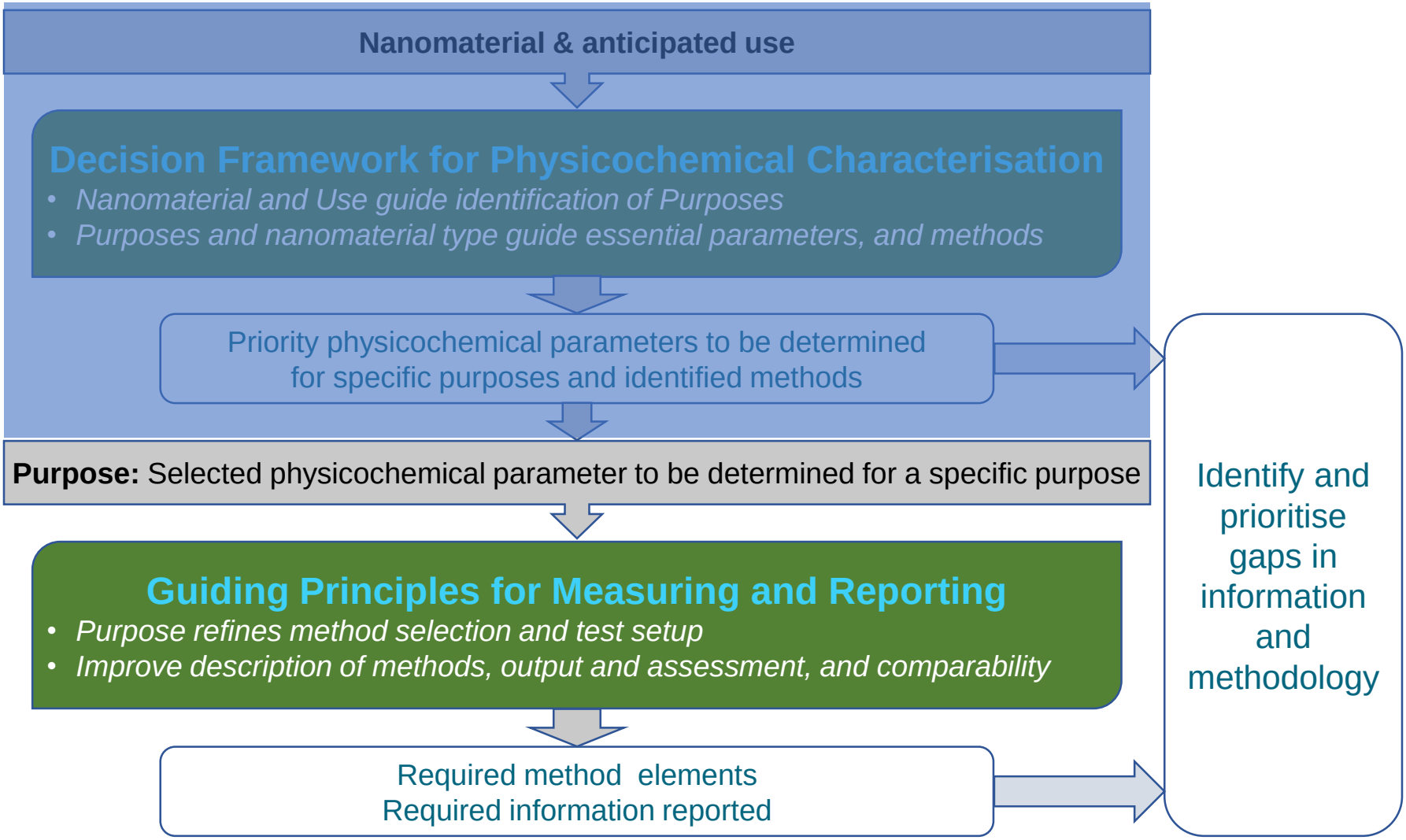


Figure 1. Physical-Chemical Decision Framework to Inform Decisions for Risk Assessment.

Guiding Principles Motivation

- **Past efforts have identified capable techniques for many parameters**
  - OECD Sponsorship Program (Rasmussen et al. 2018)
  - ProSafe
  - CEINT / NIST
  - NanoDefine
  - nanoGRAVUR
  - ISO TC 229
  … Others

- **Capable techniques do not always lead to comparable or suitable measurements**

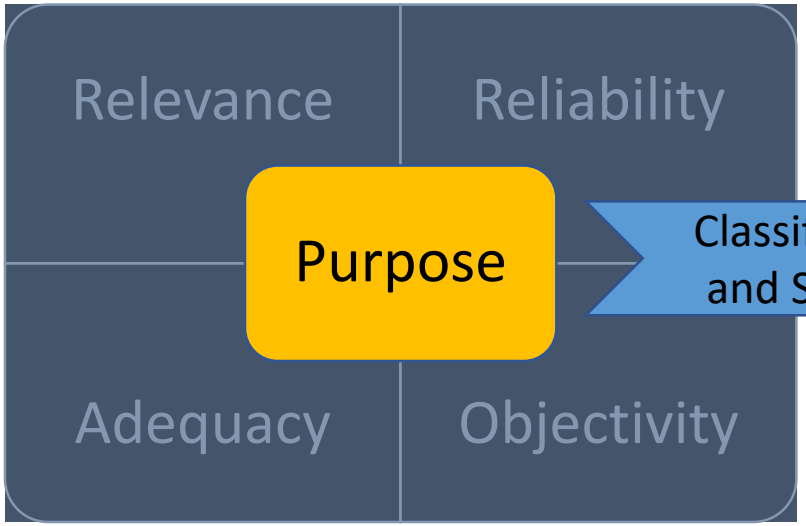
- **Communication Issues:**
  - Information received that satisfy a request is not always useful;
  - Requests for information are not always well-defined
  - Literature data is difficult to compare

- **Data created for one purpose, though the same parameter, may not be appropriate for another purpose**

Guiding Principles

A Common Approach:

- Identifying suitable analytical methods, data sources and technical approaches
- Address knowledge gaps related to the safety assessment of nanomaterials



Applications

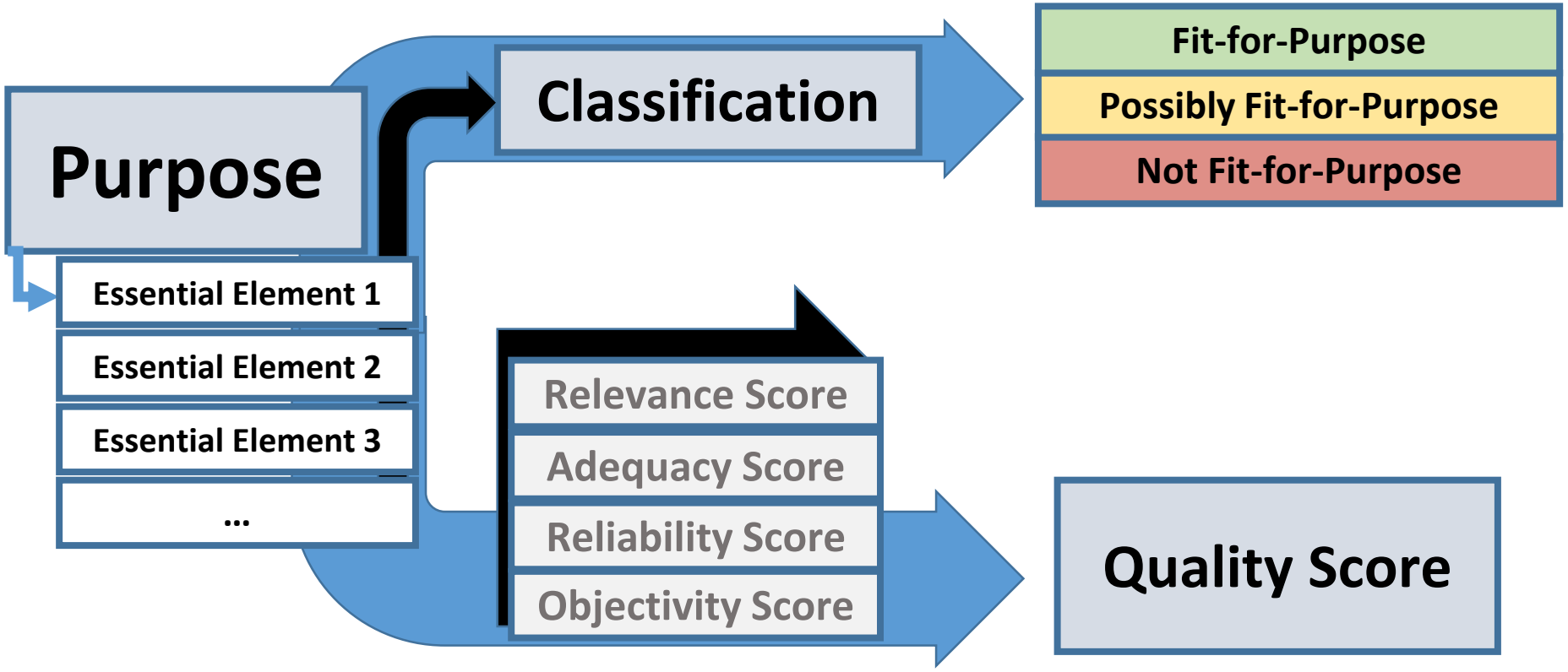
Method evaluation / selection

Reporting guidance

Method improvement

Data usability

Guiding Principles



Guidance on:

- Purpose clarity
- Fit-for-purpose Status
- Quality Status

Take home messages
Framework performance

- Framework is considered useful in general
- Do we need to fill all the boxes?
  - Most likely not, comes back to purpose
  - Identification/characterisation essential
- Purpose is key (regulatory requirements):
  - Regulatory: comes back to use
  - For other purposes (e.g. similarity)
  - When nice to know?
  - How much detail is needed?

Key Workshop
Take home messages

- The reported data allow materials to be differentiated.
- The information gathering for nanomaterial characterisation allow key decisions to be made regarding data development for exposure, fate and hazard assessments.
- Need to link to grouping/categorisation such as these projects to guide data development.
- Guiding principles appear to be thorough and well thought out but needs to be tested.

Next Steps

- Prepare a workshop summary
- Revise framework as just outlined
- Update Guiding Principles
- Finalise, and plan any follow-on efforts