Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK

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Acknowledgement

This guidance is the result of extensive consultation with and substantial input from those across the UK nuclear industry involved in nuclear material accountancy. It reflects a broad consensus on how best to satisfy safeguards and nuclear material accountancy requirements and includes numerous examples of good practice as identified by the industry.

Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK

1. Introduction

1.1. Effective nuclear material accountancy (NMA) is of fundamental importance for compliance with UK nuclear regulation and for independent verification by international nuclear safeguards inspectorates. That verification by safeguards inspectors of the European Community (EC) and the International Atomic Energy Agency (IAEA) confirms that the nuclear material has not been diverted from peaceful use. This is central to demonstrating that the UK is meeting its Euratom Treaty and other international nuclear safeguards commitments.

1.2. The management of nuclear material is vital to a nuclear site and getting the basics of NMA right in recording a true representation of reality allows for efficient independent verification. Effective international safeguards implementation in the UK is a significant part of the UK's support for the Nuclear Non-Proliferation Treaty and thus its contribution to the global nuclear non-proliferation regime.

1.3. This guide contains nearly 100 good practices relating to NMA and Safeguards and is a source for process improvements.

2. Scope

2.1. This guidance sets out the characteristics of NMA and safeguards (NMAS) systems for nuclear sites in the UK with safeguarded nuclear material and licensed under the Nuclear Installations Act. It includes the following reference annexes:

a) Annex 1 – NMAS requirements including relevant international and national legal obligations, other undertakings to which the site may subscribe voluntarily, and the UK regulatory and policy framework;

b) Annex 2 - Typical roles in a NMAS system;

c) Annex 3 - Terms and definitions (includes nuclear material covered by this guide).

2.2. The NMA requirements of this guide are relevant whether the nuclear material is for civil use and subject to safeguards or is for defence use and not subject to safeguards. Non-safeguarded nuclear material, activities and dedicated facilities are however required to be excluded from any reporting to safeguards inspectorates and from safeguards verification activities.

2.3. ***Good practice*** is that the site has clearly identified and documented the requirements, specifications and undertakings to which it adheres and applies periodic review (in order to stay current with any changes).

3. Responsibilities

3.1. NMAS requires a commitment by senior management to define and communicate unambiguous lines of responsibility and authority; to provide appropriate resources and to ensure successful implementation and effective operation. This includes the designation of a clear overall authority for NMAS. In the case of nuclear licensed sites, this authority lies with the site licence holder.

3.2. The responsibilities of the NMAS authority may be held by a specific individual, or more likely, delegated across a number of specific roles, defined at the organisation's discretion. Delegations need to be clearly documented and discharged by competent personnel. This requires

that the appropriate skill sets are defined, understood and assessed to ensure roles are carried out by suitably qualified and experienced personnel. Care should be taken to avoid having a span of responsibility too wide for any individual to execute effectively.

3.3. Responsibilities for core elements of the NMAS system are listed here (against reference titles for these roles) and act as an index for the rest of this guide. NMAS needs to be tailored to site specifics of nuclear material holdings, technology and processes, resources and organisational structures (with segregation of duties and management review proportionate to the risk). More detailed reference role duties and responsibilities are given in Annex 2.

Responsibility	Reference Role Title
4. The overall NMAS system - Accountancy and control structures - Quality management arrangements - Interfacing with safeguards inspectorates	NMAS authority (the senior management authority) NMAS Manager (day to day control of the NMAS system)
5. Measurements	
Measurement capability/quality control	Measurement controller
Sampling and analysis	Analytical Managers
6.Designing for NMAS in major new projects	Design Project Managers
7. Custody and control of nuclear material - Identification and traceability - Nuclear material movements on sites - Items in storage/under seal - Physical inventories and their verification - Commissioning/de-commissioning - Nuclear material in conditioned/unconditioned waste	Nuclear Material Custodian
8. Off site receipts/issues of nuclear material	Movement/Transport Officer
9. Accounting for nuclear material	Nuclear Material Accountants
10. NMAS in customer contract management	Commercial Contract Managers

4. The overall NMAS system

Accountancy and control structures

4.1. NMAS requires an authoritative breakdown of all nuclear materials which reflects physical reality. This breakdown needs to be localised enough to maintain appropriate nuclear material control (including rapid and effective resolution of anomalies) and enable effective and efficient safeguards verification. The safeguards inspectorates determine the level of localisation they need and define the site as comprising one or more Material Balance Areas (MBAs). The site may decide to subdivide an MBA into accountancy areas.

4.2. General guidelines for constructing accountancy areas are that physical boundaries and Key Measurement Points (KMPs) are defined to maximise the control of nuclear material flows and physical inventories (which contribute to the mass balance of each category of nuclear material held in the accountancy area) and that an accountancy area does not span more than one MBA.

4.3. Ongoing accountability and control is exercised over an accounting area by: documenting the area; assigning a Nuclear Material Custodian to control the area; conducting a regular physical

inventory of locations which can hold nuclear materials; controlling measurements; deploying performance monitoring criteria; and controlling the authenticity and technical provenance of all NMA-related data.

4.4. ***Good practice*** is that:

a) there are separate accountancy areas for: bulk handling processes; storage of discrete items of nuclear material; areas with significantly different safeguards approaches; separate physical areas of the site and separate areas of management responsibility;

b) systems cater for reconfiguration of accounting areas (merging or splitting) and the size of the accountancy area is proportionate with cost effective measurement and recording;

c) there is a single responsibility for the correct and accurate functioning of the nuclear material measurement systems used for NMAS;

d) formal handover arrangements exist within an accountancy area to enable continuity of knowledge for ongoing activities (moves, physical inventories in progress, investigations etc).

Quality Management arrangements

4.5. ***Quality Management System (QMS)*** - a site's QMS needs to ensure that all NMAS requirements are encompassed. The QMS sets-out the organisation, responsibilities, documentation, controls and operational activities of the NMAS arrangements. Documentation for current and historic system parameters includes: MBA structures; accountancy areas; Nuclear Material Custodian appointments; technical justifications; action levels; performance indicators; investigations; and current and cumulative apparent losses/gains.

4.6. ***Management review*** - review of the NMAS processes helps ensure performance is maintained and, where necessary, improved. Such review includes system effectiveness; mitigating weaknesses and risks; self-verification; measures of performance/quality; communication with regulators on deficiencies; and an annual statement for the NMAS authority on nuclear material balance anomalies.

4.7. ***Performance measures*** - monitoring and review of NMAS performance should include effectiveness of meeting NMAS requirements and identifying trends. Performance metrics will be tailored to local conditions but should include information on:

a) nuclear material control of movements, measurements and inventory;

b) NMA accuracy and timeliness;

c) anomalies; their investigation, corrective action and Learning From Experience (LFE);

d) human performance in conduct of operations so as to reduce intrinsic risk of human errors;

e) safeguards compliance, assurance and responsiveness; and

f) NMAS competence, culture and regulatory confidence.

4.8. ***Corrective actions*** - procedures to deal with NMAS incidents include escalation, investigation and corrective action arrangements. Clear escalation processes are needed for suspected loss of nuclear material control and suspected theft or diversion of nuclear material. Such processes cover conditions requiring suspension of movements/operations; the taking of a physical inventory at short notice (an Emergency Physical Inventory Taking – EPIT); and reporting to the safeguards and nuclear security authorities. Incidents classed as NMAS-related include those which:

a) are a potential loss of control of nuclear material (eg anomalies exceeding action levels, unexpected changes in containment, items which cannot be found and unauthorised movements);

b) undermine the authenticity of NMA information;

c) are non-compliant with NMAS-related requirements;

d) negatively impact the safeguards authorities (eg involve inspectors or inspection equipment); and

e) impact on customer nuclear material management and reporting.

4.9. ***Improvement action*** - procedures need to prevent recurrence of NMAS incidents and ensure wider dissemination for LFE. Incidents at other nuclear sites should also be included in LFE processes. The QMS should assign responsibility for managing improvements and the criteria for recognising when improvements are needed.

4.10. ***Good practice*** is to:

a) harmonise NMAS processes across the site;

b) have a clear and concise statement of how NMAS requirements are implemented;

c) pursue continuous improvement and adoption of better practice;

d) have an NMAS testing and comparison regime for important locations;

e) have an overall records management system compliant with or equivalent to ISO 15489; and

f) ensure that the authoritative nuclear material inventory for the site is the NMAS inventory (i.e. all nuclear material inventory (mass) information, past and present, is derived from that held in the NMAS system).

Interfacing with safeguards inspectorates and the UK Safeguards Office

4.11. ***Safeguards awareness*** - all staff involved in NMAS and who may come into contact with the safeguards inspectorates should have appropriate awareness of the legal requirements concerning safeguards, the nature of its application in the UK (a nuclear weapon state), the specifics of the site and local arrangements agreed with inspectors. More generally, the workforce that comes into contact with nuclear material should also be aware of safeguards, separate to safety and security.

4.12. ***Submissions*** - of reports and information required under safeguards regulations are to be routed via the UK Safeguards Office (UKSO) in HSE. All other safeguards-related correspondence with the safeguards inspectorates should be copied to UKSO (including for example issues affecting safeguards implementation in existing plants and in the design of new plants or refurbishment projects).

4.13. ***Particular Safeguards Provisions (PSPs)*** - the Euratom regulation can be amplified by legally binding detailed plant-specific safeguards requirements. PSPs are drawn up by and agreed with the EC safeguards inspectorate and sites, utilising information provided in the Basic Technical Characteristics (BTC) submissions. As PSPs are part of the legal basis of safeguards it is important that specific provisions remain appropriate whenever significant modifications are made to plant.

4.14. ***Information exchanges*** - must adhere to the protective markings specified by the Office for Civil Nuclear Security (OCNS) which requires that NMA reports are normally classified RESTRICTED. Classified information is required to be held, handled and transmitted in accordance with current security policy for government protectively marked information and, where appropriate, procedures for the control of commercial information.

4.15. ***Points of contact*** - ensure that UKSO and the relevant safeguards inspectorates are provided with an up-to-date listing of site contact points/addresses for safeguards inspection matters and the person(s) responsible for co-ordinating safeguards inspections.

4.16. ***Inspections*** - UK sites which store or use safeguarded nuclear material are subject to safeguards inspection. Good organisation, execution and follow-up are required to ensure consistent, competent and reliable inspection arrangements in line with the safeguards inspectorates' expectations. This requires checking understanding of scope, arrangements, purpose and responsibilities.

Normally, sites will receive advance formal notice within a week of inspections taking place, however some inspections may also be conducted at shorter notice or without any notice at all (although the latter will normally be on the basis of agreed procedures). Access procedures (including escorting and short/no notice arrangements) should be in place to keep time delays to the minimum commensurate with prevailing safety and security requirements.

Site preparations should include timetabling to avoid resource and operational conflicts and facilitating actions to ensure conditions suitable for inspection and verification. Detailed schedules and follow-up from previous inspections should be discussed and confirmed at opening meetings. Activities performed, findings and follow up requests should be discussed and confirmed in closing meetings before the inspectors leave the site. Work to address any issues raised can then be started prior to receipt of formal correspondence. These confirmations (in records of meetings) should be communicated to those involved with inspections and to UKSO.

4.17. ***Inspector's rights of access and remit*** - inspectors who are formally accepted ('designated') to undertake inspections in the UK have rights of access to nuclear material, to make measurements, to take samples, to deploy recognised safeguards techniques and to verify records that substantiate safeguards declarations as set out in the Euratom Treaty (Articles 81 and 82) and/or the UK/IAEA/Euratom Safeguards Agreement (Articles 70-89). In principle, inspectors' scope to verify nuclear materials and ensure regulatory compliance permits them access to all places, data and people as required to discharge their safeguards duties – and inspectors need not necessarily provide detailed scope or agree terms of reference for an inspection in advance, nor are they tied to past inspection custom and practice. In practice, some additional specification of what is expected is provided in PSPs and, where inspections are performed jointly by Euratom and the IAEA, Facility Attachments and associated working papers. For routine safeguards inspections to be both effective and efficient there should be planning co-operation between inspectors and sites. Sites should respond constructively and transparently to reasonable requests but safeguards inspectors have no remit to impose changes on operational activities and programmes.

4.18. ***Escorting Arrangements*** - the security policy and procedures for access arrangements to buildings and plants are detailed in the approved site security plan and require inspectors to be escorted when accessing nuclear material holding areas. Escorting duties are to be carried out by suitably qualified and experienced personnel who are aware of the scope of inspectors' rights including limits on access.

4.19. ***Safety*** - inspections are carried out in a safe manner by ensuring that escorts are fully aware of local safety procedures and inspectors are made aware of all matters of prevailing health, safety and emergency procedures, and attend the necessary site-specific training courses. Inspectors are to be prevented from compromising safety or exceeding exposure limits (see article 196 of the Euratom Treaty to the effect that inspectors shall 'comply with national rules and regulations made for reasons of public policy or public health') and from undertaking any activity that may compromise security or non-safeguarded activities.

4.20. ***Inspection follow-up*** - site's processes and systems should ensure that correspondence to/from the safeguards inspectorates is transmitted under the required protocols and is tracked and progressed in a timely fashion. Sites should be aware that such correspondence will, in the event of safeguards sanction, be part of legal proceedings. Inspector observations, their nature and resolution are assessed by the safeguards inspectorates and UKSO to gauge the level of confidence in, and maturity of, the site's systems so that trends and issues of significance can be highlighted and addressed.

4.21. ***Good Practice is to:***

a) build regulator confidence in NMAS by co-operation, transparency measures and timely communication (including of any developments that may have safeguards implications or otherwise attract significant media attention);

b) have efficient and timely access arrangements and a clear understanding by inspectors of what they can and cannot do – including requirements for escorting;

c) have specific access agreements for inspectors' own places of work on site (their offices or laboratories) which may use alternatives to escorting; and

d) ensure that organisational interfaces (between plant and accountancy) are understood and there are appropriate contingency arrangements to ensure that inspections progress without organisational problems;

e) identify and formally communicate to the EC safeguards Inspectorates (alongside the revised BTC submission) regarding any PSPs which the site considers are rendered inappropriate by significant modifications made to plant.

5. Measurements

5.1. ***Measurement limitations*** - in the perfect world, where no mistakes are made and where there are no real physical losses or gains, then the fundamental uncertainty in accounting for nuclear material lies with the precision and accuracy of the measurements. All measurement systems have limits on their capability and have associated random and systematic errors. Measurement difficulties are a common feature when dealing with nuclear material held as work in progress or as hidden inventory (held-up in the fabric of the process) and nuclear material in residues.

5.2. ***Materiality*** - measurement should make a material difference to the accountancy balances. If only trace levels of nuclear material are present in flows and stocks then such measurements should be infrequent and used to confirm that this remains the case.

5.3. ***Biases*** - these are systematic uncertainties which should be identified and removed wherever possible. If there are measurement biases that cannot be eradicated, but make a significant and well-defined contribution to the nuclear material balance (e.g. evaporation during a sampling and transfer process), it is permissible to correct for the bias on the basis of a technically justified assessment.

5.4. ***Measurement standards*** - there are ISO standards (ISO 17025 and 10012) that relate to measurement systems in general and others that relate to specific aspects of measurement (ISO 5725, 5479 etc). These together with International Target Values (ITVs) for measurement uncertainties in safeguarding nuclear materials should be used by sites which perform measurements and wish to ensure that the related basic metrological requirements are met. A high standard of NMAC measurements is especially important in bulk handling plants, where measurement accuracy contributes significantly to achieving acceptable NMAS performance. Whilst safeguards regulations call for sites to achieve quality measurements in line with most recent international standards there is also recognition that this needs to take account of old plants with high radiation backgrounds and extensive shielding where changes may be prohibitive in terms of safety and cost.

5.5. ***Measurement techniques*** - employed for the purposes of the NMAS system should:

a) be appropriately identified, and documented in NMAS procedures; and

b) be calibrated, maintained and used so as to provide accurate data in line with prevailing measurement standards.

5.6. ***Measurement Control*** - Key Measurement Points (KMP) used for accountancy require measurement control to ensure the effectiveness of measurement systems and their calibration, and thus the quality of data generated for NMAS purposes. Measurement quality control includes

approval of all NMAS related measurement procedures and the correct functioning of instrumentation and automated data collection systems.

5.7. ***Measurement Control Programmes (MCP)*** - for accountancy areas where nuclear material is processed, the statistical modelling and combination of measurement uncertainties is the accepted method for deriving an overall uncertainty associated with closing the nuclear material balance. The MCP substantiates the figures for precision and accuracy necessary to determine uncertainty action levels.

5.8. ***Inventory Difference Action Levels (IDAL)*** - when comparing the nuclear material balance determined by inventory taking (the physical inventory) with that calculated from accountancy records (the book inventory), a difference may be obtained. Actions levels for these differences are calculated by consolidating the contributing uncertainties.

5.9. ***Shipper Receiver Difference (SRD) action levels*** - action levels for SRDs will be on the basis of the measurement capability of the shipper's and receiver's equipment by statistical analysis of measurement uncertainty data associated with the respective measurement systems. Action levels for material whose shipment data is estimated/calculated will be based on historic processing norms (eg when reprocessing irradiated fuel).

5.10. ***Sampling -*** sampling is the first and arguably most important step in the analytical process and a crucial element of product quality and nuclear material characterisation. Obtaining representative and reliable samples of any bulk nuclear material being analysed is of the utmost importance. Sampling procedures are to be documented and controlled, including justification of the basis for the sampling plan, achieving a representative sample, replicate sampling, sample sub division/retention and the sampling uncertainty. The measurement uncertainty associated with the sample is an accumulation of the uncertainties in collection, handling, transportation and sub-sampling.

5.11. ***Continuous flow sampling and proportional sampling*** **-** nuclear material in liquid form is often sampled using an in line auto sampler. The NMAS system needs to include a formal description of how such samples will be applied to the flows of liquid batches. Preventative/detection arrangements need to be in place to cover failure of sampling equipment or loss of sample media and where instrument failure alarms are not practicable, local arrangements need to be in place to perform routine checks of sampling equipment functionality.

5.12. ***Homogeneous/Heterogeneous nuclear material forms*** - a totally homogeneous material requires the collection of only a single sample in order to determine its characteristics accurately, but heterogeneous materials (such as materials which demix, segregate, have large particle size, or have significant moisture take-up) require the collection of many small samples, or increments, which, when combined, will represent the batch with an acceptable degree of accuracy. These increments should, therefore, be collected from all parts of the batch, bulked, homogenised and sub sampled. The overall uncertainty in analysis of heterogeneous material is therefore dominated by the uncertainty in the sample collection process. Heterogeneity is common for many residue forms and NMAS may in these circumstances utilise estimated/average values of nuclear material composition providing such estimates have documented technical provenance (eg based on results from residue recovery) and are subject to review. Where nuclear materials to be sampled are sufficiently homogeneous, then the NMAS system may also use an average value based on:

a) the stoichiometric default; or
b) the characteristics of the feed nuclear materials (in closed batch processing systems).

5.13. ***Unmeasured nuclear material*** - in the absence of direct measurements, the NMAS system should still record the presence of all batches known to contain nuclear material (e.g. using historical estimates, by modelling, by statistical averaging or by some other form of calculation). In these circumstances the estimates should tend towards an accountancy position which least overstates reality. All assigned values/estimates should be validated, traceable, documented and approved.

5.14. ***Non-Destructive Assay (NDA)*** - where nuclear material is measured by NDA methods, then the best available unbiased estimate of nuclear material content should be used in the accounts. Built-in criticality or other safety-related biases used for other purposes within the site should not be included in data used for NMA.

5.15. ***Good practice*** in analytical measurement of nuclear material is that;

a) measurements conform to the levels of precision and accuracy specified in the ITVs for determination of nuclear material quantities in plants where access/conditions permit measurement improvements;
b) analytical measurements are made using methods and equipment with known measurement uncertainties and which have been tested to ensure fitness for their purpose;
c) the technical performance of a laboratory is subject to regular and independent assessment;
d) analytical measurements made in one location are consistent with those made elsewhere;
e) analytical provenance of a nuclear material batch is retained as long as the batch exists;
f) there is a clear relationship/traceability between the sample identification and the nuclear material batches to the which the results apply;
g) there is a formal retention and disposal policy for umpire/reference samples; and
h) the NMAS system does not delay recording a transaction because of pending analysis.

6. Designing for NMAS in major new projects

6.1. Nuclear material control is a fundamental design requirement in any major plant build and is best considered and taken into account at the earliest conceptual stage of such projects as part of the underpinning for safety, security and safeguards. At the conceptual stage it is also necessary to consider a number of strategic non proliferation and safeguards features:

a) Proliferation Resistance - these are intrinsic measures or technical barriers which either inherently impede potential for misuse of nuclear material, reduce nuclear material attractiveness or give high diversion detection capability;
b) Safeguards by Design - to ensure that safeguards requirements are fully integrated into the design process stages (design, construction, commissioning, operation and decommissioning) and the project management structure from project inception;
c) Safeguards in Depth – the use of multiple independent confidence building measures to gain safeguards assurance. This usually implies a degree of redundancy and a hierarchy of controls which collectively give higher assurance than could be gained by analysis of NMA and measurement uncertainty alone; and
d) Broader safeguards – the role of any new build in the context of broader UK fuel cycle safeguards and how these safeguards might be integrated or linked to be more effective and efficient.

6.2. The relevance of these considerations will depend on the complexity and capacity of the plant and the proliferation sensitivity/attractiveness of the nuclear materials and equipment. For High Enriched Uranium (HEU) and plutonium handling plants these considerations need to be anticipated well before a project becomes financially sanctioned. Projects need to have stated NMA and anticipated safeguards design objectives for the nuclear material inventories, flows and measurements which they address.

6.3. The site needs to ensure that NMAS legal requirements and voluntary undertakings are taken into account and that all those with NMAS responsibilities are appropriately consulted. All nuclear design decisions relating to NMAS (especially measurement and access capabilities) are to be fully documented in a controlled manner. Any design intents/implementations are to have consistent approaches to measurement objectives, performance, and quality specifications.

6.4. The site should also ensure early engagement with the safeguards authorities to define appropriate arrangements for access, verification and inspection activities. Safeguards regulations require formal declarations 200 days before construction and then again (in more detail) 200 days before introducing nuclear material.

6.5. ***Good practice*** in designing for NMAS is to:

a) share information with UKSO and the safeguards inspectorates as soon as is practicable and with their agreement. Whilst safeguards regulations don't specify engagement in the design process, early engagement is desirable as safeguards related decisions may affect the physical layout of the plant, the flow sheet design, or sizing of major plant and equipment. The timing of first engagement is a matter of judgement and based on the maturity of the design and the control philosophy; the fixing of layouts for safety cases and seismic qualification; and in tandem with other communications (to other UK regulators, to the media, for public enquiries and when notifying major nuclear investment under Article 41 of the Euratom Treaty);

b) establish the baseline NMAS arrangements, good practices, ITVs and other performance criteria for similar plants and nuclear materials;

c) establish NMAS vulnerabilities and potential system failure modes (likelihood of occurrence, impact and severity) and how these can be addressed or detected;

d) understand and manage commercial and technology sensitivities and constraints using an information (provision and logging) protocol agreed with the safeguards inspectorates and where appropriate viewing the most sensitive information only on site;

e) ensure installed safeguards verification equipment is unobtrusive and has no significant effect on plant operating cost, throughput or product quality yet enables effective and efficient safeguards (eg including by remote monitoring);

f) ensure multiple systems are resilient and have no single common point of failure to provide continuity of knowledge and preventing the need for re-verification where safeguards systems rely on containment and surveillance;

g) ensure a consistent and coherent understanding between the site and safeguards inspectorates by documenting and agreeing the safeguards approach, equipment provision, design conditions, acceptance criteria, and operational and inspection assumptions;

h) have clear contractual arrangements (installation, operation, maintenance, breakdown, replacement, waste management and decommissioning) without a profit component for any site based verification equipment owned by the safeguards inspectorates including any independent technical mechanisms for utilising site owned equipment;

i) ensure data timeliness and quality by shop floor data capture and electronic data interchange (where practical) and integration with the site's existing NMAS system;

j) provide project managers and designers with appropriate safeguards awareness training to develop a clear understanding of safeguards detection goals, access, verification and records requirements throughout the plant lifecycle;

k) have clear design arrangements for identifying, preventing or minimising the impact of unmeasured nuclear material hold up (entrapment of fissile nuclear materials on surfaces, equipment, in piping dead legs, in extract systems etc);

l) ensure storage capacities and packing densities facilitate random retrieval of items for verification; and

m) ensure there is an adequate design response to emergency inventory confirmation.

6.6. Early engagement will enable safeguards inspectorates to indicate their level of involvement during construction and commissioning. In the case of sensitive nuclear materials (especially direct use nuclear materials) there will be a significant level of inspections to verify that the plant has been constructed in accordance with the design and that the plant operates as intended. Where safeguards owned equipment is included in the design then this should be integrated into the overall plant commissioning schedule.

6.7. ***Good practice*** during construction and commissioning is to:

a) have formal NMAS consultation and sign off at proof of system concept, functional design specification and on completion of user acceptance testing. In particular, measurement performance should be proven to be within the design goal for measurement system uncertainty;

b) identify build and commissioning schedule activities which require NMAS verification or authentication. Where verification of design is required, ensure that appropriate hold points are included in the schedule and that means of access (scaffolding, etc) will be in place to allow verification;

c) provide safeguards inspectorates with an expected plant nuclear material fingerprint so that they can prioritise their verification activities and ensure they are given appropriate advance notice of cell closure or changes to cells which have already been verified;

d) avoid hold point delays and safeguards resource difficulties by conducting the majority of verification in important/complex cells before the closure point so that closure verification can be a random final check;

e) ensure key measurement points on transfer routes cannot be by-passed and that measurement qualification activities can be authenticated;

f) minimise penetrations in building fabric or biological shielding so as to reduce possible removal routes;

g) have clear arrangements for managing and protecting safeguards seals (placed on verified areas) and ensure commissioning staff and contractors are aware of their significance. This should include warning signs close to seals;

h) allow safeguards inspectorates flexibility to finalise exact positions for safeguards containment and surveillance measures to take account of field of view etc; and

i) agree protocols for direct data exchange of plant source data, read access to plant record systems and for tamper protection of information networks.

6.8. Changes to BTC information are to be notified in advance to the safeguards inspectorates where this is specified in PSPs or otherwise within 30 days after the modification is complete. All such information is to be submitted via UKSO.

6.9. IT systems are a fundamental enabler for NMAS and whenever there is a major project which impacts NMA data capture or data treatment then the design needs to include impact assessments and design requirements for NMAS. Safeguards inspectorates should also be engaged early whenever NMAS systems are replaced or substantially modified so as to include their needs in the user requirements specification.

6.10. Nuclear projects often span many years and the design, build, commissioning and operation teams are often different people. It is important to ensure continuity of the safeguards aspects and agreements throughout the different phases of the project. This also applies to the safeguards' inspector resources. Continuity processes need to ensure that NMAS agreed arrangements transition through project phases documented and intact.

7. Custody and control of nuclear material

Identification, labelling and traceability

7.1. A discrete batch or item of nuclear material requires a unique reference identity. If it is not possible to attach a label to the batch/item then an alternative identification system needs to be employed that is robust enough for the duration of that batch/item's shelf life. The item identity is the link to NMA data on the item's contents so multiple identities for the same item should be avoided. Item tracking requires traceability especially in circumstances where new identities are assigned (eg on receipt of an external shipment).

7.2. Where a container has been labelled with details of its contents, these should be obliterated when the container is emptied. Confirmation that a container is empty should be possible by independent inspection. Any non-safeguarded nuclear material present requires labelling such that it is readily distinguishable from safeguarded nuclear material.

7.3. Where nuclear material is in multiple layers of containment, then each container should be traceable to its characteristics and where several containers are together within a single container then they should be traceable either via identification or via location control within that container.

Nuclear material movements on-site

7.4. Control of internal (on site) movements is as follows:

a) document the expected nuclear material routes through and locations in each accountancy area; the accountancy points at which transfer of nuclear material custody occurs; and methods for determining the quantity of nuclear material transferred;

b) retain custodial control with the issuing accountancy area until the consignment is physically handed over to the recipient and approved on the source documentation;

c) record and authenticate all movements of nuclear material between different accountancy areas and transfer the NMA data to the Nuclear Material Accountant within one working day of the transfer taking place;

d) prove the integrity of the reporting system for fully automated systems of movement control during commissioning;

e) ensure that any manual interventions or corrections to source accountancy data are documented and traceable to the personnel involved; and

f) agree NMAS arrangements for new flows of nuclear material in an existing plant before the first movement takes place.

7.5. The records associated with nuclear material movements include information on the protective marking; on what nuclear material was moved, how and when it was transported, where it was moved from, and the handshake and confirmation sign offs. Data will include locations, batch and container identification, quantity and form, the actual date of movement, and authorisations and confirmations of those accountable. There also needs to be a means by which the movement and the items involved can be uniquely identified.

7.6. NMA data authentication requires a full audit trail to original source documents. Accounts may be updated on the basis of an electronically authorised source document, providing this is secured, retained and protected from unauthorised correction. Source data for nuclear material movements should never be amended without endorsement by the Nuclear Material Custodian or delegated nominee.

7.7. The records associated with blending or mixing of nuclear material with different isotopic compositions include a unique blend identity, where and when the blend took place, the nuclear material identity, quantity, form, and isotopic composition of the blend inputs and outputs.

7.8. Where blending and mixing of a variety of nuclear material is not aimed at producing a target product batch (eg within an analytical laboratory), then the Nuclear Material Custodian should ensure that details of the nuclear materials being blended in the batch are provided to the Nuclear Material Accountant. Where the items are small, or contain only sub-gram quantities of nuclear material, this can be aggregated on a monthly basis for NMAS purposes.

7.9. ***Good practice*** is that:

a) the overall nuclear material control system should record the actual location of nuclear material at all times, irrespective of custodial handover and pending reception acceptance/documentation;
b) transport of nuclear material on the site infrastructure (road/rail) should be accompanied by appropriate documentation;
c) nuclear material in transit is always accounted for in the site's accountancy areas and only once;
d) unplanned receipts should be rejected or quarantined;
e) shipment documentation is produced at the time of shipment; and
f) receipts are entered at the point of receipt (shop floor data capture).

Storage control and seals

7.10. Where tamper indicating devices (e.g. seals) are used by the safeguards inspectorates or by site operations for NMAS access control or to reduce verification requirements, then the devices are to be kept under suitable managerial control and in compliance with any safeguards requirements (in PSPs).

7.11. Seals applied by safeguards inspectors should only be broken with the inspectorates' consent (by providing the required advance notification) or in an emergency. When a seal is found to have been broken without authorisation or notification, the safeguards regulators require to be informed as soon as possible and they will determine whether to re-establish knowledge of nuclear material by verification and whether a special report is required. Broken safeguards seals are required to be retained and returned to the safeguards inspectorates as soon as is practicable.

7.12. The consequence of a seal break is that either equipment tamper protection or nuclear material access protection has been lost. Incident response procedures should aim to minimise the impact of potential re-verification, restore a level of protection as soon as possible, and consider suspending movements of items covered by the seal. If unauthorised breakage of a safeguards seal is due to a suspected malicious act then it should also be reported to the site's Security Manager. The unauthorised breakage of site's own seals used for nuclear material control whether by accident or deliberate should always be reported to the site's security manager.

7.13. Accountancy in storage areas is on the basis of item control and ability to locate items (i.e. data are maintained for individual items in a store and not simply for the store as a whole). Traceability and tracking require that an audit trail exists for items moved within a store.

7.14. Where a storage area uses an automated storage and retrieval system (e.g. where radiation dose levels limit access time) then that system is the primary location control system that provides the list of inventory items by location used for inventory taking. Automated systems also often have high density storage with limited capability to access or count items in the store. PIT in automated storage should include a capability to retrieve and check the control system inventory together with a full location cross check of the control system inventory with the NMAS system inventory. When an inventory item is not in the location expected by the automated system then this is a significant nuclear material control incident and requires action, which should include physical checks, to restore confidence in the location data for the store as a whole.

7.15. ***Good practice*** is to:

a) clearly mark storage locations (or easily derive them from a physical datum point);
b) segregate like containers which hold nuclear materials from those which are empty;
c) seal temporary storage of nuclear material in mobile (e.g. trailers, ISO freight containers etc) containment;
d) have a storage density which allows access to all stored items for inventory checking;
e) avoid over-labelling of containers holding nuclear materials on site. The emphasis should be on an single identity label in a form that will withstand the storage time and conditions; and
f) to record all unauthorised seal breakages as an event subject to LFE.

Physical Inventory Taking (PIT)

7.16. A PIT involves measuring or deriving estimates of all nuclear material within an accountancy area and/or MBA, and is performed in order to verify the book inventory at a given date. Unless otherwise specified in the PSPs and /or Facility Attachments (FAs), a PIT is required for each MBA every calendar year, with the period between two successive PITs not exceeding 14 months. The safeguards inspectorates require, on an annual basis, an outline programme of activities that includes provisional dates for taking a PIT - with confirmatory details of the PIT provided to the inspectorates at least 40 days prior to it taking place . Any subsequent changes to the intended programme require communication to the safeguards inspectorates without delay. Such declarations carry an appropriate protective marking and, unless agreed otherwise, are to be submitted to the EC via UKSO.

7.17. Site procedures for PIT should take into account all relevant organisational policies, management procedures and work instructions and include clear definition of responsibilities and specific criteria for the planning, housekeeping, pre-checks, conducting, and reconciling the results of the inventory. They should ensure that nuclear material movements are halted for the duration of the PIT and that the presence of all nuclear material is recorded accurately:

a) nuclear material is uniquely identified;
b) items that can be shown to have retained their integrity since last being measured do not require re-measurement but should receive some continuity check measurements to maintain confidence;
c) the amount of nuclear material held in any process areas is minimised, and there is suitable technical justification for estimates of the nuclear material quantities involved (i.e. they are not determined by the difference between receipts and issues in a particular location);
d) wherever necessary to determine its nuclear material content, nuclear material is converted to a measurable form and/or transferred to a suitable measurement location. Where this is not practicable then a technically justifiable estimate can be used;
e) nuclear material which is in a measurable form, and for which the nuclear material content is not accurately known, is homogenised, sampled and analysed;
f) all personnel who participate in the PIT are trained and have achieved the necessary competence for their area of responsibility; and
g) instruments used for nuclear material measurements at KMPs are in calibration and records of recent calibrations and derived measurement uncertainties are available.

7.18. If it is not possible to perform a direct check of all nuclear material (e.g. in areas where it cannot be safely accessed, such as reactor cores, fuel storage ponds and waste stores), then the PIT may involve the use of a sampling plan or record check as approved by the NMAS Manager. Where the PIT relies entirely on transfer records then quality controls on such records need to be undertaken, supported by assurance of the nuclear material integrity during presence in the area.

7.19. Procedures should ensure that PIT results are recorded on uniquely identified source documents that facilitate the accurate recording of data and, as a minimum, include batch and

container/vessel identities, quantitative information on number of items and bulk quantity of nuclear material; location information and accountancy area; physical and chemical form; isotopic data and category of nuclear material; and sign off data of those taking/checking the inventory.

7.20. Any corrections to PIT data are to be authorised by or with the consent of the Nuclear Material Custodian and the Nuclear Material Accountant. PIT results are reported to the safeguards inspectorates in the form of a Physical Inventory Listing (PIL), submitted along with a Material Balance Report (MBR) within 30 days of the date of the PIT.

7.21. ***Interim inventories*** - process control and/or other requirements not directly related to safeguards may mean that inventory monitoring and verification are required on a more frequent basis than an annual PIT. Such monitoring may take a number of forms, for example, process monitoring, check inventories, interim assurance or Near Real Time Material Accountancy (NRTMA). The safeguards inspectorates may take such monitoring systems into account when formulating safeguards inspection approaches.

7.22. ***Good Practice*** is that:

a) PIT frequency should be no greater than 12 months so as to allow a contingency in achieving a successful PIT/PIV within 14 months. Intervals between PITs should be of similar duration but optimising PIT intervals is risk based (taking into account the control and monitoring measures in place; the levels of inventory difference found; the accuracy of the system; plant opportunities and the degree of confidence in the system);

b) following a PIT, a timely critique of the PIT performance and anomaly resolution should be produced and communicated to those involved/responsible and to a wider site review of PIT performance and learning;

c) stores with high turnover of items (e.g. pellet store, rod store) should be subject to interim stock checks (e.g. cycle counting) in order to identify items in error earlier, thus triggering investigation, identification, and elimination of the cause of the errors;

d) sites have a detection capability for nuclear material lost during normal operations and do not rely solely on an annual PIT. Such a capability includes detection of abrupt and protracted loss consistent with safeguards authorities' detection goals on quantity and timeliness; and

e) sites are able to carry out an EPIT to confirm or discount claims (external or internal) concerning loss of nuclear materials.

Physical Inventory Verification (PIV)

7.23. PIV is the independent verification of a PIT, normally by the safeguards inspectorates of the EC or the IAEA.

7.24. All civil nuclear material is required to be presented in the form of a List of Inventory Items (LII) and made available for verification (against procedures agreed with the safeguards inspectorates and/or set-out in PSPs).

7.25. Agreed arrangements for the PIV should include its timing in relation to the PIT, so that the stock position at the time of the PIT can be maintained until the PIV is complete. If, exceptionally, there are operational reasons which mean this cannot be achieved, then the circumstances should be discussed, agreed and documented with the safeguards authorities, and the details of any movements between the PIT and the PIV highlighted and recorded.

7.26. These activities may form part of the agreed safeguards approach for an MBA and, if so, arrangements for them, including evaluation criteria, are appropriately documented as part of the NMAS procedures. If data that fall outside the evaluation criteria are identified during inventory monitoring, then the Nuclear Material Custodian ensures they are investigated and documented accordingly.

7.27. ***Good Practice*** is to:

a) reduce site operator and safeguards inspector radiation dose and to avoid damage to fuel cycle products (from handling) by seeking reduced verification by the safeguards inspectorates commensurate with maintaining safeguards assurance, proven performance and robust systems/processes.

NMAS during commissioning

7.28. Once commissioning with nuclear material begins then the nuclear material is required to be adequately controlled, accounted for and safeguarded. Design intents may not be realised during commissioning and the plant may experience equipment failures and design changes. Sites need to ensure that there is a NMA system, available as soon as nuclear material is first introduced to a plant, that is able to fully account for and report nuclear materials and can function irrespective of equipment or automation failure.

NMAS during Post Operation Clean Out (POCO) and decommissioning

7.29. The Nuclear Material Custodian and the project managers for POCO and decommissioning need to be able to obtain information on the plant history, the key NMA procedures and issues, the level of nuclear material and plant degradation present, the envisaged waste streams and the forms/quality of the nuclear material. There is also a need to know and document the effluent points and their condition (drains and vents).

7.30. Handling bulk nuclear materials gives rise to contamination and material entrapped in the plant and equipment fabric. The contamination will become apparent during decommissioning and clean out but will be in the form mostly of decommissioning wastes, which are often irregular and difficult to characterise. Unique nuclear material forms often emerge out of the unpredictability of decommissioning and plant deterioration often impacts on normal means of nuclear material access for verification. Safety errs on the side of overestimating any nuclear material present (and by doing so also ensures conformance to waste acceptance criteria) whereas NMA needs to ensure it uses the best (unbiased) estimate.

7.31. POCO aims to lower the plant process inventory to as near to empty as possible. A technically justified inventory taken from records and cumulative inventory difference should be established and used as baseline during the decommissioning process. There should be decommissioning project management awareness of these inventory levels.

7.32. ***Good practice*** is to:

a) establish a plant nuclear material 'finger print' using suitable direct measurement techniques. This is likely to have a large uncertainty and be inappropriate for use in accounting for nuclear material hold up but gives valuable location and distribution information;

b) plan for rapid analysis of waste drums and 'real time' radiography of 'mixed' waste; and

c) investigate when the level of nuclear material arising from POCO and decommissioning exceed the baseline estimate to ensure there is no excessive over estimation of nuclear material in wastes; establish any LFE (on hold up) for similar fuel cycle plants and re-establish a new baseline.

7.33. Buildings or plants identified for decommissioning or closure remain subject to safeguards requirements and this guidance until it is determined that all nuclear material has been removed. The Physical Inventory can then be recorded as zero, and any remaining difference from the book inventory recorded as an ID. The safeguards authorities can then amend the safeguards status of the building or plant to reflect the absence of nuclear material.

7.34. The UK has a legacy of fuel cycle operations (defence and civil) dating back well before the advent of IAEA or monthly safeguards reporting to the EC. When dealing with gains of nuclear

material from decommissioning legacy facilities or finding legacy items, the gains are to be accounted for as follows:

a) where gains are expected from the decommissioning of contaminated process areas then they are to be declared as new measurements;

b) where such nuclear material is known to be of defence operations origin or from a period of plant operation pre-dating safeguards (1973) they are to be accounted for as receipts from non-safeguarded activity; and

c) where legacy nuclear material in item or bulk form of unknown origin (which cannot be traced to previous reporting) is found unexpectedly then it is to be reported as an accidental gain.

7.35. All gains are to be based on the best available figures, ideally following direct measurement.

7.36. ***Good practice*** should achieve an NMAS end-state which exhibits the following characteristics:

a) an agreed position that safeguards has been terminated or a static position with each batch of nuclear material having its associated trace history and characterisation data; and

b) knowledge, information and data concerning safeguards and NMA which is required for long term archive is identified together with those data which are candidates for a national nuclear archive.

Waste monitoring, conditioning, storage and disposal

7.37. The nuclear material content of waste inventories has to be accounted for but is not subject to routine mass balance and safeguards reporting requirements. Wastes, including their nuclear material content are covered by the NII 'Safety Assessment Principles for Nuclear Facilities' and joint HSE, Environment Agency, Scottish Environment Agency (SEPA) guidance on radioactive waste management and characterisation.

7.38. Nuclear materials in waste are subject to reduced requirements for safeguards reporting and verification. In operational plants, the BTC documents required by the EC safeguards inspectorate identify waste streams and arrangements for monitoring the flows of waste. Acceptance of the BTC documents by the safeguards inspectorates therefore represents tacit agreement that, providing there is a means to verify the flow, then the nuclear material involved can be reported as waste for safeguards purposes.

7.39. ***Good practice*** for operational plant issues to waste for safeguards purposes is that:

a) each waste batch contains a low nuclear material content and the transfer to waste is measured in some way with a target measurement uncertainty of <25% (quoted in the IAEA Safeguards Glossary as the expected measurement uncertainty associated with closing a material balance for waste storage);

b) the waste volume and form mean that its nuclear material content is irrecoverable either for practical, technical or economic reasons;

c) the nuclear material has no identified use and has an identified waste route and will be consigned to a plant which only handles waste and for which it meets the Conditions For Acceptance (CFA); and

d) any unconditioned waste streams are of low proliferation sensitivity/attractiveness and meet the criteria for termination of Euratom safeguards on nuclear material in waste.

7.40. For nuclear material in wastes streams not previously identified in BTCs then the site needs to seek endorsement from UKSO and the safeguards inspectorates that the stream is acceptable as a waste stream. Examples include legacy residues for which no processing route or further use can be found, and for decommissioning residues which are often heterogeneous. Such arisings may have forms which are difficult to characterise and subject to bands/range estimates of nuclear material

content. Measurements using non destructive assay techniques may, because of the waste form and low nuclear material content have higher measurement uncertainty than the 25% indicated for closing a material balance on waste arising from fuel cycle processes. However, the magnitude of the components of uncertainty should be known and correctly propagated to form a technically justified total uncertainty.

7.41. ***Good practice*** for legacy stocks of nuclear materials being reported as waste for safeguards purposes is that:

a) there is no existing processing/recovery route available in the UK or abroad nor is one currently planned;
b) the nuclear material content is based on a justified calculation or a measurement which falls within a target uncertainty range of <25%;
c) no use has been identified for the material form and there is no external interest;
d) planning assumptions are that the material form is a liability and it is classified as waste on the UK radioactive waste inventory;
e) the waste conforms to a waste plant CFA or has at least a first stage Letter of Compliance(LOC) for acceptance in the UK Geological Disposal Facility (GDF);
f) the material form will be consigned to a plant which only handles waste; and
g) the waste will be conditioned into a low proliferation sensitivity/attractiveness form within a limited (safeguards set) timeframe.

7.42. EC Regulation (Euratom) 302/2005 specifies that waste for safeguards purposes can be either 'retained' or 'conditioned'. The approach adopted in the UK is to simplify reporting by using only the 'retained' category (but particular circumstances in which use of the 'conditioned' category may be more appropriate should be discussed with UKSO and the safeguards inspectorates). Nuclear material transfers to waste will be included in safeguards reports as transfer to retained waste (transaction code TW). Such waste is stored at the MBA for which the transfer is reported, but is not included in the accountancy reports required by Commission Regulation (Euratom) 302/2005.

Processing of retained waste, without moving it from its MBA, can be performed without returning the waste to the main inventory. However, if the processing involves the separate of elements, then site is required to inform the safeguards inspectorates of such processing in its programme of activities, records for which (including the quantities of waste material involved) are to be made available at the site.

7.43. An initial stock list of the nuclear material contained in waste was required as part of entry into force of EC Regulation (Euratom) 302/2005. The listing should include details of the total amounts of nuclear material for each MBA by nuclear material category, broken down by individual storage areas and types of waste. The ongoing requirement is that stock changes are recorded such that a book inventory can be provided when requested by safeguards inspectors.

Euratom safeguards requirements for an annual physical inventory taking are not as formal for material contained in waste, and there is no requirement to produce and report Physical Inventory Listings or Material Balance Report. However, a stock list must still be produced annually after a stock taking exercise. This stock taking exercise can be done on the basis of the best available values of the nuclear material, and does not need to involve its re-measurement or direct physical verification.

7.44. Nuclear material accounts for nuclear material in waste should be updated with the same frequency as other nuclear material accounts, i.e. as soon as possible after changes have taken place. An up-to-date stock list and documentation in support of the figures (e.g. including information on all movements) are to be made available on site as requested during safeguards inspections.

7.45. Euratom safeguards can be terminated on nuclear material that has been irrevocably discarded to the environment as the result of a planned discharge. The nuclear material contained in such discharge is measured or estimated on the basis of measurements. Euratom safeguards may

also be terminated on waste containing very low concentrations of nuclear material, indicative levels for which are given in the EC Guidelines published to accompany the Regulation. Such termination is however by agreement with the EC safeguards inspectorate and UKSO. Arrangements for the termination of IAEA safeguards are to be discussed and agreed with UKSO.

7.46. ***Good practice*** is to:

a) ensure passive safe storage and long term management options are compatible with safeguards and non-proliferation commitments;

b) include sufficient breakdown of nuclear material form in the NMA so as to be useful for asset/liability management; and

c) have retained waste in one MBA.

8. On/Off site movements of nuclear material

8.1. Control of external receipts into and issues out of the site is as follows:

a) each site has a nominated person with overall responsibility for nuclear material in transit to or from the location; and

b) accountancy data are transmitted to Nuclear Material Accountants within one working day of receipt or issue of nuclear material.

8.2. ***Good Practice*** is to use of electronic data exchange between consignor and consignee for regular and detailed consignments.

Receipts onto sites

8.3. Agreement should be obtained from the relevant Nuclear Material Custodian before delivery is agreed;

8.4. Nuclear material receipts are physically checked as far as practicable against accompanying source data (eg which should indicate or allow the derivation of nuclear material weight, isotopic composition, the safeguards obligation code and, where available, the MBA code for the shipper), including check measurements where appropriate. The nuclear material is not released for use until these checks are complete.

8.5. The NMAS system uses the shipper data. If, after measurement, a difference is found outside the acceptance criteria and a correction is not supplied by the shipper, then the data is instead corrected to the site's values by declaring a Shipper Receiver Difference (SRD).

8.6. A management procedure or escalation process is needed to deal with receipts that have no accompanying nuclear material documentation or for nuclear material subsequently found in equipment or apparently empty containers received at the site.

8.7. If, on receipt, the data recorded on the shipper's documentation are clearly in error then the shipper should provide corrected documentation (personnel at the receiving site are not to amend shipper's documentation). Until a difference is resolved, the shipment follows a quarantine procedure.

8.8. Advance notification of certain imports is required to be communicated to the EC (as specified in Article 21 of EC Regulation (Euratom) 302/2005) Unless otherwise stated, such notification has to reach the Commission at least five workings days before the nuclear material is unpacked, carry the appropriate protective marking and be submitted via UKSO.

Issues from sites

8.9. Formal agreement for transfer is needed from the consignee, prior to the dispatch of any nuclear material from the site.

8.10. Nuclear material is appropriately measured and accounted for before dispatch and NMAS shipping advice notes produced.

8.11. Advance notification of certain exports is required to be communicated to the EC (as specified in Article 20 of EC Regulation (Euratom) 302/2005). Unless otherwise stated, such notification has to reach the Commission at least eight workings days before the nuclear material is packed for shipment, carry the appropriate protective marking and be submitted via UKSO.

8.12. An auditable system of checks should be in place to ensure that nuclear material is not shipped from the site in apparently empty containers.

9. Accounting for nuclear material

Compilation of accounts

9.1. ***Book inventories*** and balances for nuclear material are updated so that source data are recorded in the accounts within one working day of their creation. Nuclear material accounts for each accountancy area are finalised (and statemented) when PIT data become available and the nuclear material balance has been calculated and the ID derived. This should be as soon as possible following the end of the material balance period and as agreed with the safeguards inspectorates. Subsequent corrections will then apply to the accounts for the period in which the correction is made.

9.2. ***Source (operating) data*** and associated records to substantiate reports to the EC and if necessary reconstruct the accounts (eg if any part of the system is destroyed or rendered ineffective) are required to be maintained for 5 years from the date on which they were generated. All accountancy information is to be readily traceable from its generation as source data through to final production of NMAS reports.

9.3. ***Units of accountancy*** for nuclear material;

a) quantities of nuclear material are required to be expressed in grams for reporting to the safeguards authorities. NMA is therefore expressed in units of grams, or smaller;
b) uranium accounts are required for each nuclear material category (natural, depleted or enriched) in terms of total uranium. A single (unified) category may be agreed with safeguards authorities for bulk processes which are dominated by a particular category;
c) uranium accounts are required to record the fissile component for low and high enriched uranium stocks;
d) plutonium accounts are required to be kept in terms of total plutonium (and may also record fissile content); and
e) where nuclear material is present as discrete items, then the nuclear material accounts should also be balanced by number of items.

9.4. ***De minimis reporting levels for nuclear material*** - uranium is present in the natural environment, for example in rocks and in the sea at concentrations measured in parts per million and its is recognised that there are concentration or other threshold factors beyond which it is inappropriate to account for nuclear material. More specifically:

a) European Commission Regulation No. 9 of February 1960 specifies application of the Euratom Treaty to uranium ores containing 0.1% or more uranium, thorium bearing ores containing 3% or more thorium, and monazites containing 10% thorium or 0.1% or more uranium;
b) safeguards reporting requires that any batch which rounds up to a gram of nuclear material is reportable, but also allows for reporting of milli-grams (3 decimal places of grams) – implying a de minimis level in the range of 0.001 to 0.499 grams; and
c) Euratom guidelines to accompany EC Regulation 302/2005 include criteria for concentrations of nuclear material in waste on which safeguards can be terminated (1 part in 1,000 depleted

and natural uranium, 1 part in 5,000 of Low Enriched Uranium, 1 part in 100,000 of High Enriched Uranium and 1 part in 250,000 of plutonium). Therefore it would not be appropriate to bring onto account traces of nuclear material in the form of a contaminant in a bulk of material destined for disposal or non nuclear use if it meets those criteria.

9.5. ***Good Practice*** is to:

a) account for sub gram items held in discrete containers and which have higher concentrations of nuclear material (eg metallic uranium or plutonium), especially if there are large number of such items. In this case, such items can be aggregated and reported as a single batch with a number of items.

b) record all item nuclear material weights to the same level of significance (as determined by the sensitivity or capability of the measurement) for the purpose of aggregating.

9.6. ***Timeliness of recording data*** - timeliness is a key aspect of the capability of an accountancy system to provide an up-to-date statement of nuclear material inventories, and so the system aim should be to record transactions within one working day of them taking place. The nuclear material accountancy system should show both the date the transaction took place and the date it was entered into the books, and include means of monitoring any delay. Where the required accountancy data rely on results from sampling and analysis, provisional estimated data should be entered, and identified as such.

9.7. ***Data errors*** - the accountancy system should include procedures to minimise data errors resulting from misreading or incorrect data transmission or calculation, with checking mechanisms employed to provide timely detection of errors, discrepancies or omissions in records.

9.8. ***Conventions*** for NMA transactions - all accounting or recording conventions used in deriving nuclear material quantities from source data are to be documented and approved.

9.9. ***Corrections***:

a) to NMAS transactions should be in a form that indicates what has been changed along with both the old and new values;

b) to transactions that have not already been reported formally to the safeguards inspectorates should be recorded, but only the corrected transaction need be included in formal reporting;

c) to transactions that have already been reported formally to the safeguards inspectorates should be recorded, with that correction also included in the next formal report submitted;

d) in formal reports to the safeguards inspectorates should be by means of deletion and addition of the reporting lines concerned, or use of the New Measurement (NM) inventory change code, as agreed with those inspectorates; and

e) all corrections should show the date of the correction and the identity of the person making the correction.

9.10. ***Category changes***:

a) where blending or mixing of batches of nuclear material with different isotopic compositions leads to a change of nuclear material category (e.g. from high enriched uranium to low enriched uranium), the change is reported in the accountancy area in which the blending occurred and needs to take into account/balance the uranium, the U235/233 and the obligation codes involved;

b) if a category change is required as a result of a new analytical result, it is reported in the accountancy area where the nuclear material arose and any subsequent transactions already declared are treated in accordance with the procedure for corrections.

9.11. ***Re-batching***:

a) where a batch or batches of nuclear material are re-batched into new discrete batches, then a full audit trail is maintained between the original and new batch(es); and

b) re-batching takes place entirely within one accountancy area and one category and should not give rise to any discrepancies other than rounding.

9.12. ***Nuclear production*** - the generation of nuclear material as a result of irradiation (e.g. in a reactor) is required to be accounted for. Such production in irradiated fuel is reported to the safeguards authorities when the fuel is transferred from the reactor MBA or otherwise within 12 months of the fuel being discharged from the reactor. Elsewhere, nuclear production should be accounted for and reported as specified in PSPs or otherwise agreed with the safeguards authorities.

9.13. ***Nuclear loss*** - information on the conversion of uranium and plutonium and on decay isotopes for plutonium and reference dates for their calculation should (if recorded for operational reasons) be provided to the safeguards inspectorates on request.

9.14. ***Rounding*** - quantities may be rounded down when the first decimal is 0 to 4 and rounded up when the first decimal is 5 to 9. Individual nuclear material accounting records may be rounded in such a manner as to ensure they remain meaningful - in particular to enable their summation to provide reports accurate to the nearest gram.

9.15. ***Change of safeguards status*** - (i.e. nuclear material withdrawn from or brought under safeguards), nuclear material can only be withdrawn from safeguards following UKSO approval of a request made in advance. UK Government policy is that withdrawals are limited to small quantities of nuclear materials not suitable for weapons purposes, the details of which are made public. Non-safeguarded nuclear material can only be brought under safeguards from the UK military cycle following approval from the MoD. Separate notification should be provided to UKSO.

9.16. ***NMAS documentation and data***;

a) all NMA data, whether for safeguards, commercial or other purposes, need to be derived from and readily reconcilable with a single set of source data (the same nuclear material is not to be the subject of parallel accountancy systems /arrangements);

b) all documentation and data associated with the nuclear NMA system requires appropriate protective marking in accordance with the classification policy issued by OCNS. It is held, handled and transmitted in accordance with current security policy for government protectively marked information and, where appropriate, procedures for the control of commercial information. Personnel require appropriate security clearance for the information or IT systems to which they have access;

c) NMA data needs to be readily retrievable for independent audit/verification. NMA data reflects the quantity of nuclear material on inventory for each MBA, including details of nuclear material received and issued and other inventory changes. The records system should be capable of being updated on a daily basis or on-demand for all nuclear material transactions, and of producing book inventory figures for MBAs within one working day; and

d) all records used for NMA are to be traceable to an authenticated source and kept in a manner that guarantees traceability. In particular, all mass values for effluents, discards, wastes and accidental losses require a traceable history.

9.17. ***Record retention*** - disaster recovery processes need to include the reconstruction or reconstitution of the nuclear material accounts for any MBA or accountancy area, if any part of the accountancy system for that area is destroyed or rendered ineffective. The source data and accompanying records necessary to reconstruct the accounts are to be maintained for a period of at least 5 years following the end of the accountancy period in which they were created. Note however that Nuclear Site Licence Condition 6 requires 'the licensee shall make and implement adequate arrangements to ensure that every document required, every record made, every authorisation, consent or approval granted and every direction or certificate issued in pursuance of the conditions attached to this licence is preserved for 30 years or such other periods as the Executive may approve'.

9.18. ***Computer records*** - IT management systems should:

a) assure the authenticity and security of data. This includes protection from training and program testing activities;
b) have a configuration controlled environment for quality assurance and provide a full audit trail of data and programme changes, so as to enable independent confirmation;
c) provide a description to the safeguards inspectorates of the computerised NMA system at least to a level which documents the data handling procedures;
d) ensure the computer system has the appropriate OCNS accreditation; and
e) ensure that any migration/upgrade strategy includes suitable arrangements for maintenance of data integrity during migration and provision of long term record storage and retrieval capability of historic data not migrated.

9.19. ***Good Practice*** is that:

a) nuclear material accounts record measurements at the precision of the measurement device (irrespective of the measurement accuracy), are balanced (the sum of the debits = the sum of the credits), are current (have running as opposed to periodic balances), and are statemented and presented to the Nuclear Material Custodians;
b) where there are many accounts then additional higher level controlling accounts are used;
c) nuclear decay is conducted on legacy holdings of plutonium as it is transferred to retained waste;
d) negative balances are immediately reviewed and investigated; and
e) separate nuclear material accountants are maintained to distinguish reactor depleted uranium from unirradiated uranium of the same nuclear material category.

Inventory Difference and Shipper Receiver Difference

9.20. ***Inventory Differences*** (IDs) - An ID is calculated as:

ID = closing physical inventory minus opening physical inventory minus receipts plus issues

A positive ID is therefore referred to as an apparent nuclear material 'gain' and a negative ID as an apparent nuclear material 'loss'.

9.21. ***IDs in process plants*** are recorded in the nuclear material accounts for the plant in which they are determined. These should be tested for significance against the limits of error identified by the MCP. If, exceptionally, no MCP is in place then interim action levels can be assigned using historic performance or the IAEA values for the "expected measurement uncertainty associated with closing a material balance" under normal operations quoted in the IAEA Safeguards Glossary.

Facility type	**relative standard deviation, δ_E**
Uranium enrichment	0.002
Uranium fabrication	0.003
Plutonium fabrication	0.005
Uranium reprocessing	0.008
Plutonium reprocessing	0.010
Separate scrap storage	0.04
Separate waste storage	0.25

Where the relative standard deviation above is multiplied by the facility throughput.

9.22. ***Differences in stores*** - may arise in stores as a result of rounding, when batches are issued as two or more sub-batches. Such differences are recorded as rounding adjustments and not IDs.

Differences can also arise from analytical results or mistakes in batch details. An amendment to the quantity associated with a package in a store should not generate an ID in that store. The difference between the original and amended quantities is instead transferred back, as a correction to the original receipt, to the area in which the package arose, or generates an SRD in the case of external receipts.

9.23. ***Re-characterisation of old stock*** - where it is necessary to confirm or refresh characterisation data for a batch it is normal for any sampling/re-containerisation to be conducted in a process (contact) area. Differences which arise from such characterisation can be recorded as new measurement in that process area and not passed back to plant of origin. Where the process performs other fuel cycle operations, then re-characterisation differences should be recorded separately from normal plant performance/ID action levels.

9.24. ***Finds of nuclear material*** - finds of nuclear material where the presence of nuclear material is both unexpected and unusual are normally brought onto inventory using the inventory change code Accidental Gain (GA). Use of this code requires a special report to be sent to the EC. Unless there is evidence that the nuclear material has been accounted for previously, the inventory change should not be included in consolidated figures for IDs. Additional advice on safeguards reporting in such circumstances can be obtained by contacting UKSO and advice on security reporting should be obtained from the site security manager.

9.25. ***Significant IDs*** - IDs are identified as significant at the 3 sigma, 99% confidence level with follow-up required at the 2 sigma level. For accountancy areas where nuclear material is stored in the form of discrete items, the IDAL is one or more items. The NMAS manager is responsible for specifying IDALs, records for which (and their derivation) are to be maintained for all accountancy areas on the site.

9.26. ***Shipper/Receiver Differences*** (SRDs) - an SRD is calculated as:

SRD = Receiver value minus Shipper value

9.27. SRDs should not exist between accountancy areas within the same site, where there should be procedures to ensure that shipping and receiving areas use the same figure for the quantity of nuclear material transferred. Agreement should be on the basis of measurement and not, for example, commercial or financial convention.

9.28. Where a site's processes generate a better understanding/measurement of nuclear material content received from another site then any difference can either be recorded using SRD or by correcting the shipment documentation. SRD is the normal method for regular differences such as those arising from reprocessing spent fuel.

9.29. Action levels for SRDs are deemed significant at the 3 sigma, 99% confidence level. Warning levels should be set at the 2 sigma level. The NMAS manager is responsible for specifying SRD action levels. In the case of reprocessing SRDs action levels will vary depending on fuel type and burn up.

9.30. Formal NMAS-related response procedures need to exist for:

a) IDs or SRDs that exceed action levels including any that involve discrete items;
b) unexpected changes in the containment of nuclear material, to a point where unauthorised removal of nuclear material has become possible ; and
c) anomalies that are deemed significant by a Nuclear Material Custodian or Nuclear Material Accountant including items that cannot be found at their recorded location.

9.31. The procedures should ensure:

a) the abnormal ID or SRD is documented immediately it is identified (eg during a PIT or PIV). It is not appropriate to wait for the results of investigatory work before documenting and reporting the ID (i.e. such documentation should be the trigger for investigation);
b) the Nuclear Material Custodian ensures the investigating officer issues an initial report within 14 days of the initial recording of the ID or SRD; and

c) the investigation remains open until a final report on the incident is issued and this is accepted by the NMAS Manager.

9.32. Wherever possible, nuclear material that has been subject to significant SRDs should not be further processed or converted into other batches until management approval has been obtained. Normally, this would only be after management is satisfied that adequate measures have been taken to resolve the SRD.

9.33. ***Cumulative IDs and SRDs*** - These figures should be maintained such that lifetime positions by accountancy area and by plant are available. Trends should be identified and investigated.

9.34. ***Good practice is that***:

a) when IDs occur due to re-measurement then the difference should be open to validation against the original and new measurement methods, the rational for accepting the new measurement and (in cases of gross differences) assurances about batch integrity;

b) a trend of linked IDs of opposite sign should be investigated. This includes coupled MBAs with opposite sign inventory differences (e.g. regular pattern of gains in one in line with losses in another) and includes mixed uranium/plutonium streams (one category losses and the other gains); and

c) an MCP is used for bulk handling plants (safeguards regulations only require that measurements comply with standards and that a site describes its control of accuracy, statistical evaluation and determination of errors and error propagation).

10. Customer contract management - NMAS aspects of ownership, obligation and origin

10.1. ***Customer entitlements*** - the site should be able to identify the owner of all nuclear materials; this may be by identifying individual items as belonging to specific owners or by allocating nuclear material in an area between owners. Commercial contract information on customer entitlements for nuclear material are to be derived from the same set of source data as is used to substantiate nuclear material accounts and safeguards declarations. Accounts for all customers should be available on a timescale appropriate to permit reconciliation with the nuclear material accounts.

10.2. ***Nuclear material on loan*** - owners have the responsibility to keep records of nuclear material issued on loan to another site or third parties. Site NMAS systems are not required to do so.

10.3. ***End-use obligations*** - nuclear material obligations are commitments on use assumed under nuclear supply or co-operation agreements (e.g. between Euratom and the USA, Canada and Australia). Reporting on such obligations is therefore a requirement of the EC Regulation (but is not a feature of IAEA safeguards implementation) and a responsibility of the site. Obligations on peaceful end use (as agreed with supplier States and administered by the EC) are to be identified and accounted for using obligation codes (or 'flags'), assigned by the EC as an additional accountancy characteristic for the nuclear material concerned.

10.4. ***Obligation Accountancy***:

a) obligation account stocks need to reconcile with total site stocks and total customer account stocks;

b) methods of allocating obligations (e.g. the principles of fungibility, proportionality and equivalence) should be fully documented;

c) obligation accountancy for any blending of enriched uranium of different isotopic compositions is based on the uranium-235 and/or uranium-233 content, with appropriate adjustments on total uranium.

d) obligation exchanges between different sites or owners are possible. The owners involved (or their delegated authorities) have the responsibility to seek prior authorisation by the safeguards authorities. The EC will seek confirmation of details by the site and reporting of the exchanges once authorisation to proceed is given. Such approvals are kept as part of the NMA record.

10.5. ***Pool accountancy*** - sites may have arrangements for the operation of an "Obligation Pool". There is no requirement to use pool accountancy, but a site or group of sites may do so providing the arrangements are agreed and documented with the safeguards authorities. Procedures need to ensure correct and traceable allocation of obligation codes to all NMA transactions and to action any obligation code swaps and loans. Addition of any new plants to the pooling arrangements must be by agreement with UKSO and the EC safeguards inspectorate.

Obligations are allocated on nuclear materials transferred to waste, but nuclear material in retained or conditioned waste is no longer considered as part of the pool and no longer under any requirements for obligation following and reporting.

The reality of a pool is that once nuclear material enters the pool it assumes a pool obligation flag which is used for all movements within the pool. The stocks of each obligation code are accounted for at the pool level and need not be allocated/tracked against specific items in the pool.

10.6. ***Good practice is that***:

a) in a pool where PSPs require batch follow up on certain feed and product stocks then the NMAS system should maintain a record of the actual obligations as received onto the site or allocated to finished products that are to be shipped;

b) waste which is to be returned to customers as conditioned waste should be accounted for using obligation code "P"; and

c) waste for which a technical or economic solution for nuclear material recovery becomes available should be returned to the full safeguards account in line with the obligations reported when the material was originally transferred to waste.

11. Closing remarks

11.1. Compilation of this guidance has included extensive consultation with the UK nuclear industry. It therefore reflects a UK industry consensus regarding what constitutes good practice in an NMAS system.

Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK

ANNEX 1 – NMAS requirements

1. Scope

1.1. The purpose of identifying Nuclear Material Accountancy and Safeguards (NMAS) requirements is to ensure that operations take into account not only the law and the UK's safeguards-related commitments, but also other standards, guidance, codes of practice etc. to which the site may subscribe voluntarily. Knowledge and awareness of requirements reduces the likelihood of violations. Reference links to regulatory texts are given in the table below.

1.2. Requirements, specifications and undertakings including the following:

a) the legal framework for implementing international safeguards in the UK (including safeguards-related requirements of international agreements on nuclear co-operation);
b) other safeguards-related commitments made by the UK government (e.g. in response to parliamentary questions or public inquiries) and policy direction which is not specified in law;
c) agreements made with customers related to NMAS or management of its nuclear materials;
d) agreements made with safeguards authorities not specified in regulations;
e) any other requirements concerning authorisation, derogations, permits etc. for nuclear material;
f) voluntary codes of practice and guidelines; and
g) public commitments given by the site or its parent organisation;

1.3. It is important to bear in mind that, notwithstanding safeguards-specific requirements, there is considerable domestic regulation of those responsible for nuclear material in the UK which includes requirements that bear on Nuclear Material Accountancy (NMA). Nuclear Installations are operated under licenses granted by under the Nuclear Installations Act 1965. These licenses include specific conditions relating to the handling and control of nuclear matter, and the 'Safety assessment principles for nuclear facilities' used by the Nuclear Installations Inspectorate (NII) to assess performance against site licence conditions include a number that relate to NMA (e.g. see paragraphs 392 – 417 regarding the control of nuclear matter). Other legal instruments that those responsible for nuclear material in the UK must comply with include the Radioactive Substances Act, the Ionising Radiation Regulations and the Nuclear Industries Security Regulations 2003. Effective NMA is a necessary part of the basis for being able to comply with all the legislation involved.

1.4. Responsibility for compliance extends to sub-contractors and leaseholders on site. This includes NMAS policies and activities:

a) compliant with information classification guides and the site's security plan approved under the Nuclear Industries Security Regulations 2003;
b) to support investigation of suspected theft or diversion of nuclear material; and
c) to resolve conflicting security and safeguards requirements

Sub-contractors access to NMA data must be in line with security clearances, need-to-know principles and UK export controls.

2. International regulation

2.1. Components of the regulatory framework that provide specifically for the implementation of international safeguards in the UK are described below.

Euratom Treaty safeguards

2.2. The UK signed the European Atomic Energy Community (Euratom) Treaty as part of joining the European Economic Community in 1973, and the safeguards chapter (Title II, Chapter 7) of the Treaty requires that the European Commission (EC) satisfies itself that civil nuclear material (essentially plutonium, uranium and thorium) in the Euratom member states is not diverted from its declared peaceful end uses, and that obligations relating to material which has been supplied under international nuclear co-operation agreements are respected. The means by which the EC achieves these safeguards objectives are also outlined in the Treaty as:

a) reporting by the operators of nuclear installations (as provided for in Articles 78 and 79 of the Treaty and further specified in EC regulation (Euratom) 302/2005); and

b) EC inspection of the installations and the nuclear material concerned (as provided for in Articles 81 and 82 of the Treaty).

In addition, the safeguards chapter provides for sanctions (ranging from a published written warning to withdrawal of the nuclear material concerned) by the EC in the event of infringement of the Treaty safeguards obligations. The European Communities Act 1972 and associated legislation (eg The European Communities (Enforcement of Community Judgments) Order 1972) is the basis for implementing Euratom safeguards requirements in the UK, and enforcing EC decisions arising from that implementation.

2.3. The safeguards requirements of the Euratom Treaty also extend to those responsible for nuclear material which is not held at licensed nuclear sites. NMAS guidance tailored to what is required of so-called 'small holders of nuclear material' (SHNM) will be provided separately by the UK safeguards Office (UKSO).

IAEA safeguards

2.4. Although the Nuclear Non-Proliferation Treaty (NPT) does not require its five defined nuclear-weapon states (NWS) parties to adopt safeguards agreements, the states concerned (China, France, Russia, the UK and the US) have each concluded so-called voluntary offer safeguards agreements with the IAEA. Whilst these agreements follow the basic structure of the standard model agreement for non-nuclear-weapon states (NNWS) they are based on fundamentally different safeguards undertakings which, in effect, recognise that the NWS continue to have nuclear activities outside the scope of IAEA safeguards and thus limit IAEA activities to all or part of the NWS' civil nuclear activities. In the case of the UK the basic undertaking in the tripartite UK/Euratom/IAEA safeguards agreement (INFCIRC/263) is the UK's acceptance of the application of IAEA safeguards *'on all source or special fissionable material in facilities or parts thereof within the United Kingdom, subject to exclusions for national security reasons only'.*

2.5. The safeguards reporting requirements of INFCIRC/263 are met by the reports submitted to the EC for Euratom safeguards purposes (EC regulation (Euratom) 302/2005 above), which the EC then provides to the IAEA. The EC fulfils the responsibilities of the State System of Accountancy and Control (SSAC) required by INFCIRC/263.

2.6. The access required for IAEA safeguards inspectors under INFCIRC/263 is provided for in the Nuclear Safeguards and Electricity (Finance) Act 1978 (the access required for Euratom safeguards inspectors is a function of the Euratom Treaty).

2.7. An Additional Protocol to INFCIRC/263 provides for the implementation of measures that contribute to increasing the IAEA's capability to detect undeclared nuclear activities in non-nuclear-weapon states (NNWS) or improve the effectiveness or efficiency of IAEA safeguards at facilities in the UK. Reporting and access requirements of the additional protocol are provided for in the Nuclear Safeguards Act 2000 (which requires information on nuclear fuel cycle or related research, and allows access in connection with such information) and the associated Nuclear Safeguards (Notification) Regulations 2004.

2.8. The UK also has continuing safeguards reporting obligations under a bilateral safeguards agreement with the IAEA (INFCIRC/175), which predates the INFCIRC/263 voluntary offer agreement, although IAEA safeguards inspection obligations arising from the INFCIRC/175 agreement are now performed under the INFCIRC/263 agreement.

2.9. UK reporting in respect of the IAEA's monitoring of the proliferation risk posed by neptunium and americium follows from notices issued under the Atomic Energy Act 1946 that require reporting to UKSO on holdings and exports of separated americium and neptunium – coupled with the Atomic Energy (Americium) Order 2002, which prescribed americium for the purposes of the act (neptunium was prescribed by the original act).

Other UK safeguards-related commitments

2.10. There are, in addition, bilateral and multilateral nuclear supply or co-operation agreements entered into by the UK or the EC (on behalf of the European Atomic Energy Community) which include important NMAS-related provisions:

a) the UK/Japan agreement on nuclear co-operation, which requires annual reporting to the Japanese authorities on nuclear material subject to the agreement and which is substituted for that material; and

b) the UK/Australia agreement on nuclear transfers, under which annual reports of subject nuclear material are provided to the Australian authorities.

The EC is responsible for ensuring that safeguards-related requirements of agreements entered into by the European Atomic Energy Community (e.g. with the USA, Canada, Australia and Japan) are met.

2.11. The UK Government has also made safeguards-related commitments in respect of:

a) the international guidelines for the management of plutonium, which include annual publication of figures for UK holdings of civil plutonium in separated form and in irradiated fuel. UK publication of figures for plutonium is accompanied by figures for the UK's civil uranium stocks (high and low enriched, natural and depleted);

b) annual publication, on behalf of the UK nuclear industry, of Nuclear Material Balance figures; and

c) annual publication of information on nuclear material withdrawn from safeguards in the UK.

2.12. Exports of nuclear material from the UK are also subject to UK export control requirements, which are a matter for the export control organisation of the Department for Business Innovation and Skills (BIS).

3. UK Safeguards Office (UKSO)

3.1. The role of UKSO in the Nuclear Directorate of the Health and Safety Executive includes working with the international safeguards inspectorates of the EC and the IAEA so that safeguards obligations for the UK are met in a proportionate manner. UKSO does not attempt to duplicate the activities that the EC must perform in fulfilling its responsibilities under the Euratom Treaty and as the SSAC required by the INFCIRC/263– but is directly responsible for fulfilling UK requirements that

are not part of the EC's safeguards remit. These include key aspects of the reporting summarised above, notably:

a) providing the IAEA and the EC with an annual update of the list of all UK facilities which contain civil nuclear material and are therefore eligible for inspection by the IAEA under INFCIRC/263;
b) providing declarations to the IAEA under the additional protocol to INFCIRC/263. Detailed guidance on the requirements of the UK additional protocol and the associated UK legislation is available at the website of the UKSO or by contacting UKSO direct;
c) reporting to the IAEA on separated neptunium and americium; and
d) providing the IAEA with reports as required by the INFCIRC/175 safeguards agreement.

3.2. UKSO is also responsible for reporting and/or publishing information in respect of the UK Government's other safeguards-related commitments, specifically:

a) reporting to the Japanese authorities on nuclear material subject to the UK/Japan agreement on nuclear co-operation;
b) reports to the Australian authorities on nuclear material subject to the UK/Australia agreement on nuclear transfers;
c) publication of figures for UK holdings of civil plutonium and uranium;
d) publication, on behalf of the UK nuclear industry, of Nuclear Material Balance figures; and
e) publication of information on nuclear material withdrawn from safeguards in the UK.

3.3. UKSO fulfils its roles and responsibilities on the basis of information provided to it by the international safeguards inspectorates and those subject to safeguards in the UK. Were UK duty holders to default on their obligations to provide such safeguards information, whether to the international inspectorates and/or UKSO, UKSO has powers of access to safeguards-related information and associated locations under the Nuclear Safeguards Act 2000 - in respect of the UK Additional Protocol, and the Atomic Energy Act 1946 - more widely.

3.4. Detailed information on proposed arrangements for transferring the UKSO safeguards functions to a new Office for Nuclear Regulation (ONR) is included in a draft Legislative Reform Order (LRO) and accompanying draft explanatory document published by the Government in March 2010.

4. Other NMAS guidance, standards and codes of practice

4.1. There are, in addition, a number of other sources of advice on nuclear material accountancy including:

a) EC guidance on the implementation of a nuclear material accountancy and control system by operators of nuclear installations, published in the form of EC Recommendation 2009/120/Euratom;
b) a 'Nuclear Material Accounting Handbook' complied under IAEA auspices;
c) 'Guidelines for Good Practice in Nuclear Material Accountancy and Control Systems' compiled by the European Safeguards Research and Development Association (ESARDA) Focus Group on accountancy and audit; and
d) other related guidance as identified in the final section of the attached Table.

4.2. A common theme throughout the available guidance is that judgement must be exercised in applying practices to individual circumstances whilst still meeting the overall objectives of good NMAS.

5. Requirements for nuclear material outside safeguards

5.1. Nuclear licensed sites used solely for defence purposes are not subject to safeguards requirements. Nevertheless, it is MOD policy to have NMA standards and management arrangements that are, so far as reasonably practicable, at least as good as those required by safeguards legislation.

5.2. Civil nuclear licensed sites which handle nuclear materials which are excluded from safeguards for reasons of national security/defence requirements are expected to comply with the MOD requirements as specified in the SW PT ANM Accounting and Control Manual for all MOD owned nuclear material.

Reference documents and Links

INTERNATIONAL and EUROPEAN UNION	
The Nuclear Non Proliferation Treaty (NPT)	http://www.iaea.org/Publications/Documents/Treaties/npt.html
UK/IAEA/Euratom safeguards agreement - INFCIRC/263	http://www.iaea.org/Publications/Documents/Infcircs/Numbers/nr251-300.shtml
Additional Protocol to the UK/IAEA/Euratom Safeguards Agreement	http://www.hse.gov.uk/nuclear/safeguards/protocol.htm
UK/IAEA safeguards agreement – INFCIRC/175	http://www.iaea.org/Publications/Documents/Infcircs/Numbers/nr151-200.shtml.
International Guidelines for Plutonium Management IAEA INFCIRC/549	http://www.iaea.org/Publications/Documents/Infcircs/Numbers/nr501-550.shtml
Euratom Treaty, European Commission(EC) regulation (Euratom) 302/2005 and accompanying guidance in the form of EC recommendation (2006/40/Euratom)	http://www.hse.gov.uk/nuclear/safeguards/euratomreq.htm and at http://eur-lex.europa.eu/en/treaties/dat/12006A/12006A.htm
EC Recommendation on the implementation of a nuclear material accountancy and control system by operators of nuclear installations (Published in Official Journal of the European Union on 12 February 2009, 2009/120/Euratom	http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2009:041:SOM:EN:HTML
EC 'Guidelines for the implementation of Euratom International Nuclear Co-operation Agreements'	copies can be obtained from UKSO
European Communities Act 1972	http://www.opsi.gov.uk/acts/acts1972/ukpga_19720068_en_1
European Communities (Enforcement of Community Judgments) Order 1972	http://www.opsi.gov.uk/si/si2003/20033204.htm
NATIONAL	
Nuclear Installations Act 1965	http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1965/cukpga_19650057_en_1 .
Safety Assessment Principles for Nuclear Facilities' 2006 Edition, Revision 1 issued by HSE NII's	http://www.hse.gov.uk/nuclear/saps/index.htm.
Radioactive Substances Act 1993	http://www.opsi.gov.uk/acts/acts1993/Ukpga_19930012_en_1.htm
Ionising Radiation Regulations 1999	http://www.opsi.gov.uk/si/si1999/19993232.htm.
Nuclear Industries Security Regulations 2003	http://www.opsi.gov.uk/si/si2003/20030403.htm
Nuclear Safeguards and Electricity (Finance) Act 1978	http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1978/cukpga_19780025_en_1

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Nuclear Safeguards Act 2000	http://www.opsi.gov.uk/acts/acts2000/ukpga_20000005_en_1
Nuclear Safeguards (Notification) regulations 2004	http://www.opsi.gov.uk/si/si2004/20041255.htm
Atomic Energy Act 1946	http://www.opsi.gov.uk/RevisedStatutes/Acts/ukpga/1946/cukpga_19460080_en_1
Atomic Energy (Americium) Order 2002	http://www.opsi.gov.uk/si/si2002/20022533.htm
Export of Goods (Control) Order 1994	http://www.uk-legislation.hmso.gov.uk/si/si1994/Uksi_19942518_en_1.htm
The Agreement of 25 February 1998 between the United Kingdom of Great Britain and Northern Ireland and the Government of Japan for Co-operation in the Peaceful Use of Nuclear Energy	http://www.fco.gov.uk/en/about-us/publications-and-documents/treaty-command-papers-ems/treaty-command-papers-by-subject/nuclear-atomic-energy
The Agreement of 24 July 1979 between the United Kingdom of Great Britain and Northern Ireland and the Government of Australia concerning Nuclear Transfers between the United Kingdom and Australia	http://www.austlii.edu.au/au/other/dfat/treaties/1979/11.html
Draft Legislative Reform Order (LRO) and draft Explanatory Document on Government proposals to restructure the Health and Safety Executive's Nuclear Directorate	http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/reg_reform/reg_reform.aspx
UK POLICY	
Annual publication of UK stocks of civil plutonium and uranium	http://www.hse.gov.uk/nuclear/safeguards/iaeauk.htm
Annual UK publication of 'Nuclear Material Balance' figures ('Material Unaccounted For')	http://www.hse.gov.uk/nuclear/safeguards/materials.htm
Annual publication of information on nuclear material withdrawn from safeguards in the UK	http://www.hse.gov.uk/nuclear/safeguards/withdrawals.htm
VOLUNTARY/GUIDANCE	
Guidance on the sensitivity of nuclear-related information "Finding a Balance"	http://www.hse.gov.uk/nuclear/ocns/balance.pdf
'Nuclear Material Accounting Handbook' IAEA Service Series 15, published May 2008	http://www-pub.iaea.org/mtcd/publications/PubDetails.asp?pubId=7828

'Guidelines for Good Practice in Nuclear Material Accountancy and Control Systems' as compiled by the European Safeguards Research and Development Association (ESARDA) Focus Group on accountancy and audit	copies can be obtained from UKSO
Regulatory Standard S-336, CNSC Safeguards and Nuclear Non-Proliferation Reporting Requirements, September 2006	http://www.cnsc-ccsn.gc.ca/pubs_catalogue/uploads/S-336_e.pdf
NRC Regulations, Title 10, Code of Federal Regulations (CFR) PART 74--MATERIAL CONTROL AND ACCOUNTING OF SPECIAL NUCLEAR MATERIAL	http://www.nrc.gov/reading-rm/doc-collections/cfr/part074/
International Target Values 2000 for Measurement Uncertainties in Safeguarding Nuclear Materials	
ISO/IEC Guide 98-1:2009 -GUM: Guide to the expression of uncertainty in measurement	http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?ics1=17&ics2=020&ics3=&csnumber=46383
Code of Practice for the Calibration of Industrial Process Weighing Systems (2003)	http://resource.npl.co.uk/docs/science_technology/mass_force_pressure/clubs_groups/instmc_weighing_panel/wgc0496.pdf
Measurement management systems – requirements for measurement process and measuring equipment - ISO standards 17025 and ISO 10012 (BS EN ISO 1002:2003)	http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030099404 http://www.iso.org/iso/catalogue_detail?csnumber=26033
Tank calibration and volume determination for nuclear materials accountancy	ISO Standards 18213-1 to 6:2007-2009
ISO 5725 (parts 1-6) Accuracy (trueness and precision) of measurement methods and results 1994	http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=11837&utm_source=ISO&utm_medium=RSS&utm_campaign=Catalogue
Joint HSE, Environment Agency and Scottish Environment Protection Agency (SEPA) regulatory guidance on radioactive waste management - including on waste characterisation	http://www.hse.gov.uk/nuclear/wastemanage.htm.
Glossaries of safeguards terms	http://www.hse.gov.uk/nuclear/safeguards/glossary.htm and from the IAEA http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdf

Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK

Annex 2 – Typical roles in a NMAS system

1. Site overall NMAS Authority

1.1. The Nuclear Material Accountancy and Safeguards (NMAS) authority referred to in this guidance is the entity within the organisation of the 'person or undertaking setting-up or operating an installation' accountable to the UK Safeguards Office (UKSO) and the safeguards inspectorates of the European Commission (EC) and the International Atomic Energy Agency (IAEA)) for NMAS-related requirements for all nuclear material held by the site. In the case of nuclear licensed sites, the NMAS authority would be the site licence holder.

1.2. The NMAS authority reviews and, as appropriate, authorises the site's Nuclear Material Accountancy (NMA) policy, ensuring that it satisfies the requirements of UKSO and the safeguards inspectorates. As a minimum, the NMAS authority undertakes management review of the annual nuclear material accounts and other key issues in the application of safeguards at the organisation. The authority therefore has overall responsibility for ensuring:

a) measures to promote awareness of the requirements of NMAS throughout the organisation and, in particular, for the functional areas identified below;

b) sufficient human resources for effective implementation of NMAS policy;

c) specific NMAS responsibilities, based on those described below, are recorded in personnel job specifications and any necessary training is identified;

d) staff are effectively trained and demonstrably competent (i.e. suitably qualified and experienced) to carry out their work and responsibilities in respect of the NMAS system. Records will therefore need to be maintained to show that staff with NMAS-related responsibilities have been trained and demonstrated their competence.

1.3. Similarly, the NMAS authority also has overall accountability for infrastructure-related issues such as ensuring that the NMAS system is supported by appropriate IT platforms.

2. NMAS Manager

2.1. An NMAS Manager would be nominated by the NMAS authority as someone independent of the site's production functions with responsibility for setting NMAS policy and monitoring its implementation including:

a) maintaining organisational policy on NMAS in line with legislative requirements by documenting the management structure for NMAS; agreeing the boundaries of accountancy areas and specifying action levels for Inventory Differences (IDs) and Shipper/Receiver Differences (SRDs);

b) ensuring that procedures relating to the data processing (eg generation, transmission etc) of NMAS data are available and issuing site-specific NMAS procedures as appropriate;

c) ensuring the resulting NMAS responsibilities are clearly delegated within the organisation, for example, by the appointment of Nuclear Material Custodians such that NMAS systems are established and implemented in all accountancy areas;

d) monitoring the interpretation and implementation of NMAS policy, ensuring the adequacy and performance of NMAS systems and promoting NMAS awareness throughout the organisation (e.g. by means of independent assessment or audit). This includes ensuring the organisation maintains adequate levels of NMAS-related competence (e.g. that the necessary training programmes are implemented for Nuclear Material Custodians and Nuclear Material Accountants, including competency assessment and refresher training), and thus that there are sufficient resources for effective implementation of NMAS policy;

e) approval and issue of all reports made to the safeguards inspectorates and to UKSO (and, as appropriate, to the Office for Civil Nuclear Security (OCNS) through the site's security manager) concerning significant NMAS-related events or discrepancies, including, in particular, those on any actual or suspected unplanned changes in nuclear material inventory, unexpected changes in the containment for nuclear material and loss or delay of nuclear material during transfer that are required by Articles 14, 15 and 22 of EC Regulation (Euratom) 302/2005;

f) advising on and, where appropriate, endorsing projects that impact on NMAS to ensure that all NMAS requirements are met in any new or substantially refurbished plant or software system. It is particularly important to ensure that such requirements are recognised and addressed at an early stage in new projects as back-fitting the necessary provision can involve substantial avoidable costs;

g) monitoring the implementation of any NMAS requirements agreed during project implementation (including in terms of mitigating any adverse impact of other project requirements on NMAS);

h) maintaining appropriate compliance information and historic NMA data in line with prevailing regulatory requirements;

i) undertaking consolidated review of all NMA data (including material balances) at least once a year, and reporting findings from this review to the NMAS authority; and

j) ensuring that inspection activities performed by the safeguards inspectorates of the EC and the IAEA can be undertaken to their satisfaction. This will include nominating or identifying personnel responsible for co-ordinating safeguards inspections within the site's organisation.

2.2. Where any of the above responsibilities are delegated by the NMAS Manager, the NMAS Manager maintains a supervisory role, and is regarded as the site's primary point of contact with the NMAS Authority, the safeguards inspectorates and UKSO.

3. Nuclear Material Accountants

3.1. Nuclear Material Accountants would normally be appointed by and report to the NMAS Manager, with responsibilities expected to include:

a) maintaining accurate auditable nuclear material accounts that are readily traceable to source data which are available from Nuclear Material Custodians or their staff and third parties in providing timely information on the disposition of nuclear material;

b) producing balanced nuclear material accounts by Material Balance Area (and accountancy areas) and material balance period (i.e. the period between two Physical Inventory Takes, PITs). This includes preparing accountancy reports for submission to the safeguards inspectorates, ensuring that ID results from PITs are reported to Nuclear Material Custodians in a timely manner and there is similarly timely information to management on any significant discrepancy in accountancy data. Accountancy reports required by EC Regulation (Euratom) 302/2005 (e.g. Inventory Change Reports (ICRs), Physical Inventory Listings (PILs), Material Balance Reports (MBRs)) must be submitted to the EC via UKSO;

c) preparing the Basic Technical Characteristics (BTC) documentation required by EC Regulation (Euratom) 302/2005 for submission to the safeguards inspectorates, and ensuring that

requirements in the Particular Safeguards Provisions (PSPs) agreed on the basis of BTCs are identified and responsibility for each requirement is defined (e.g. including appropriate advance notification of changes as required by the safeguards inspectorates). BTCs must be submitted to the EC via UKSO;

d) providing the safeguards inspectorates with advance notification of imports and exports of nuclear material as required by EC regulation (Euratom) 302/2005. Such notifications must carry the appropriate protective marking and be submitted via UKSO;

e) preparing procedures for the compilation of nuclear material accounts in the light of organisational policy and procedures for the generation and transmission of NMA data. This includes approving significant changes to procedures or data recording/collection systems and ensuring that new NMAS software is validated and that acceptance testing is performed; and

f) ensuring that audit measures are in place to confirm the validity of data and to conduct self-audits to check data quality, including procedures to investigate suspected data falsification or tampering.

4. Nuclear Material Custodians

4.1. Custody of (i.e. direct responsibility) for nuclear material at large sites is a matter for those responsible for operations in the particular plant areas etc. where the material is present. The term 'Nuclear Material Custodian' is used in this guidance for the individuals to whom specific such responsibility is assigned by those with authority for the plant operational areas concerned. Nuclear Material Custodians at large sites are therefore managerially distinct from the internally independent NMAS function and have responsibilities which include:

a) control of all nuclear material within their accountancy area(s) and regular review of their systems for NMA and supporting the implementation of safeguards measures against the corresponding organisational policy (in which respect the term *'inventory control'* is defined as *'a quality control programme aimed at ensuring agreement between records and the physical situation in a timely manner. Inventory control should include resolving and reporting on found discrepancies as well as reconciliation with other local accounts and central accounts'* in the recently published EC Recommendation 2009/120/Euratom on nuclear material accountancy and control systems);

b) ensuring appropriate levels of self-verification for NMAS and that measures of NMAS performance, including Key Performance Indicators (KPIs), are in use, regularly reviewed and acted on;

c) ensuring that a Measurement Control Programme (MCP) is in place for their accountancy area(s), action levels for IDs and SRDs are applied, and appropriate investigative action is instigated when action levels are exceeded. This includes systems of measurement quality control applied to all the measurements used for NMA in the accountancy area(s) – including confirmation that shippers' measurement systems which are the source of accountancy data used in the receiving area are under adequate control, and appropriate sampling and analytical schedules for all sample points in the accountancy area(s), with analytical results from such sampling available to the Nuclear Material Accountants within appropriate timescales;

d) ensuring that a PIT is conducted in each accountancy area at least annually. This includes the availability and use of appropriately plant-specific procedures, instructions and authorities to prepare for and perform the PIT so that the plant conditions at the time are as specified by the organisational policy on NMAS;

e) ensuring that NMA data is transmitted to the Nuclear Material Accountants in a timely and efficient fashion. This includes procedures to avoid data and transcription errors;

f) notifying the Nuclear Material Accountants of changes in NMA arrangements or which otherwise affect information on the accountancy areas(s) which must be declared to the safeguards inspectorates (in the form of BTCs) before such changes take place;

g) documenting investigation of all discrepancies brought to their attention in their accountancy area(s) by Nuclear Material Accountants or others, and ensuring they are reported to the NMAS manager;

h) making provision for the training needs of personnel within their accountancy area(s) to understand the importance of NMAS and enable them to perform their NMAS duties; and

i) ensuring that stocks of and records for any nuclear material which is not subject to safeguards requirements are segregated and clearly labelled.

5. Movement/Transport Officers

5.1. Sites may have other personnel with specific responsibility for all external shipments and receipts. The NMAS duties of such a Movement/Transport Officer are expected to include:

a) ensuring that all NMAS documents required for the issue of nuclear material from the site are generated prior to shipment;

b) ensuring that all required approvals and licences have been obtained prior to the transport of nuclear material to or from the site, arranging and recording the use of licences as appropriate;

c) ensuring that cancellations and postponements of external shipments/receipts for which paper work has been raised are duly notified to the Nuclear Material Custodians and Nuclear Material Accountants concerned;

d) ensuring that all sub-contracts or third party carriers have appropriate quality systems, with documented hand-over and carriage arrangements/procedures such that nuclear material control is maintained at all times;

e) ensuring that all in-transit incidents or unauthorised external receipts are reported to the appropriate management; and

f) providing notification to and confirming the necessary contract endorsement ('concurrence') have been obtained from the Euratom Supply Agency (ESA) as required under Articles 52 and 75 of the Euratom Treaty.

6. Design Project Management

6.1. Design Project Managers with responsibility for new plants/stores, or significant changes to existing plants/stores are expected to:

a) implement agreed NMAS design provisions identified in this guidance in the design of new and refurbished plant;

b) seek endorsement from the NMAS Manager for the NMAS arrangements planned for any new or refurbished facilities;

c) seek endorsement from the NMAS Manager for the NMAS provisions in any new or refurbished NMAS-related software. IT projects that affect any subsidiary systems should also be notified to the Nuclear Material Custodians and Nuclear Material Accountants; and

d) ensure that new or refurbished radiometric instruments used for NMA purposes provide output with measurement uncertainties which are consistent with accepted International Target Values (ITVs) for such equipment.

7. Commercial Contract Management

7.1. Commercial Contract Managers are expected to:

a) ensure contracts take account of the contents of this guidance. Advice should be sought from the NMAS Manager before signing contracts that may impact on the operation of the NMAS systems (e.g. contracts that may affect the precision and accuracy of nuclear material accountancy measurements);

b) ensure contracts fully respect safeguards requirements for accounting for supplier and other material 'obligations' attached to nuclear material (including, where appropriate, the use of 'obligation pools'). Approval should be sought from the NMAS Manager before committing to exchanges (e.g. 'swaps') of such obligations;

c) ensure that customers' contractual entitlements to nuclear material (e.g. the obligations concerned, and the nature of the nuclear material) are consistent with NMA records;

d) notify the appropriate Movement/Transport Officer, Nuclear Material Custodians and Nuclear Material Accountants in advance of planned receipts and issues of nuclear material; and

e) notify the NMAS Manager of all contracts relating to nuclear material in order to enable European Supply Agency (ESA) notification and concurrence as required by Articles 52 and 75 of the Euratom Treaty.

8. Analytical Measurement Management

8.1. Analytical Managers are expected to:

a) ensure that appropriate destructive and non-destructive analysis techniques are in place to provide NMA data to the standard required by the NMAS Manager;

b) ensure analytical techniques and measurement instrumentation provide output data with measurement uncertainties that are consistent with accepted ITVs for such techniques, and that records are maintained which demonstrate analytical performance against appropriate certified reference material (e.g. including, where possible, participation in relevant inter-laboratory comparison exercises); and

c) inform the NMAS Manager in a timely manner of any bias identified in measurement systems and the implications for the accuracy of reported NMA data.

9. Measurement Controller

9.1. Measurement Controllers are ideally organisationally independent to those performing measurements and either directly responsible for or have oversight of:

a) measurement quality and authenticity;

b) measurement performance, including for PIT;

c) the planning, development, coordination, and administration of a measurement control program;

d) the appropriate use of and traceability to reference standards;

e) the measurement resources (equipment, instruments and procedures used in performing a measurement);

f) hold up modelling and statistical handling of measurement errors;

g) improvements to eliminate/minimise significant source of bias or improve measurement capability; and

h) measurement disputes.

Guidance on International Safeguards and Nuclear Material Accountancy at Nuclear sites in the UK

ANNEX 3 – Terms and definitions

1. Nuclear Material – Safeguards and other definitions

1.1. The terms *'Nuclear Material(s)'*, *'Source Material(s)'*, *'Special Fissile Materials'* and *'Ores'* are used in this guidance with the meaning as defined in the Euratom Treaty and European Commission (EC) Regulation (Euratom) 302/2005. Sites subject to safeguards requirements should however be aware of slight differences between these terms and definitions and similar terminology as used by the IAEA, and more significant differences when compared with non-safeguards definitions in UK-specific legislation.

Euratom definitions of nuclear material

1.2. Article 197 of the Euratom Treaty states that:

1.3. 'For the purposes of this Treaty:-

a) ***'Special fissile materials'*** *means plutonium 239; uranium 233; uranium enriched in uranium 235 or uranium 233; and any substance containing one or more of the foregoing isotopes and such other fissile materials as may be specified by the Council, acting by a qualified majority on a proposal from the Commission; the expression special fissile materials' does not, however, include source materials.*

b) *'Uranium enriched in uranium 235 or uranium 233' means uranium containing uranium 235 or uranium 233 or both in an amount such that the abundance ratio of the sum of these isotopes to isotope 238 is greater than the ratio of isotope 235 to isotope 238 occurring in nature.*

c) ***'Source materials'*** *means uranium containing the mixture of isotopes occurring in nature; uranium whose content in uranium 235 is less than the normal; thorium; any of the foregoing in the form of metal, alloy, chemical compound or concentrate; any other substance containing one or more of the foregoing in such a concentration as shall be specified by the Council, acting by a qualified majority on a proposal from the Commission.*

d) ***'Ores'*** *means any ore containing, in such average concentration as shall be specified by the Council acting by a qualified majority on a proposal from the Commission, substances from which the source materials defined above may be obtained by the appropriate chemical and physical processing*

1.4. Article 2.4 of EC Regulation (Euratom) 302/2005 states that:

'*Nuclear materials*' *means ores, source material or special fissile material as defined in Article 197 of the Euratom Treaty*.'

1.5. Annex III/Section 25 of the Regulation specifies categories of nuclear material as follows:

Plutonium
High enriched uranium (20 % enrichment and above)
Low enriched uranium (higher than natural but less than 20 % enrichment)
Natural uranium

Depleted uranium
Thorium

IAEA definitions of nuclear material

1.6. Article XX of the IAEA Statute states that:

1.7. 'As used in this Statute:

a) *The term "**special fissionable material**" means plutonium-239; uranium-233; uranium enriched in the isotopes 235 or 233; any material containing one or more of the foregoing; and such other fissionable material as the Board of Governors shall from time to time determine; but the term "special fissionable material" does not include source material.*

b) *The term "uranium enriched in the isotopes 235 or 233" means uranium containing the isotopes 235 or 233 or both in an amount such that the abundance ratio of the sum of these isotopes to the isotope 238 is greater than the ratio of the isotope 235 to the isotope 238 occurring in nature.*

c) *The term "**source material**" means uranium containing the mixture of isotopes occurring in nature; uranium depleted in the isotope 235; thorium; any of the foregoing in the form of metal, alloy, chemical compound, or concentrate; any other material containing one or more of the foregoing in such concentration as the Board of Governors shall from time to time determine; and such other material as the Board of Governors shall from time to time determine.'*

1.8. Paragraph 112 of the model Comprehensive Safeguards Agreement with the IAEA (INFCIRC/153) states that:

*"**Nuclear material**" means any source or any special fissionable material as defined in Article XX of the Statute. The term source material shall not be interpreted as applying to ore or ore residue.'*

UK security definitions of nuclear material

1.9. The term *'nuclear material'* is also defined in UK-specific legislation. Section 76(7) of the Anti-terrorism, Crime and Security Act 2001 states that:

1.10. "nuclear material" means -

a) *any fissile material in the form of uranium metal, alloy or chemical compound, or of plutonium metal, alloy or chemical compound; or*

b) *any other fissile material which may be prescribed by regulations made by the Secretary of State,'*

Previously separated americium-241, 242m and 243 and neptunium-237 that are not irradiated are now prescribed as nuclear material by Section 3(1) of the Nuclear Industries Security Regulations 2003.

UK Safety definitions of nuclear matter

1.11. The term *'radioactive nuclear matter'* is defined in the Nuclear Installations Act (NIA), Section 26(1) as

1.12. "***nuclear matter***" means, subject to any exceptions which may be prescribed—

a) *any fissile material in the form of uranium metal, alloy or chemical compound (including natural uranium), or of plutonium metal, alloy or chemical compound, and any other fissile material which may be prescribed; and*

b) *any radioactive material produced in, or made radioactive by exposure to the radiation incidental to, the process of producing or utilising any such fissile material as aforesaid.*

2. Glossary of Key Terms, Abbreviations and Acronyms

2.1. Description of some of the terms below includes their definition as included in EC regulation (Euratom) 302/2005 or EC recommendation 2009/120/Euratom.

2.2. ***Accountancy area*** - A uniquely identified area, wholly within a single MBA, with its own nuclear material account. The physical boundaries of an accountancy area are defined by the operator, in contrast to those of an MBA, which are defined by the safeguards inspectorates.

2.3. ***Anomaly*** - Defined for Euratom safeguards purposes at Section 2.11 of 2009/120/Euratom as a 'discrepancy or series of discrepancies that are consistent with the absence or gain of a significant amount of nuclear material'. An anomaly can be detected during an investigation of discrepancies of whatever kind.'

2.4. ***Basic Technical Characteristics*** (BTCs) - Design information for plants or locations where safeguarded nuclear material is stored or used as required by Article 3 of (Euratom) 302/2005. BTCs include a description of the installation, the form, quantity, location and flow of nuclear material being used, the layout of the installation, containment features and procedures for nuclear material accountancy and control. The information is used, inter alia, to prepare the safeguards approach for the installation and any Particular Safeguards Provisions (PSPs). The equivalent in the IAEA system of safeguards is known as Design Information (DI).

2.5. ***Batch*** - Defined at Article 2.11 of (Euratom) 302/2005 as 'a portion of nuclear material handled as a unit for accounting purposes at a key measurement point and for which the composition and quantity are defined by a single set of specifications or measurements. The nuclear material may be in bulk form or contained in a number of items'. Examples of a batch therefore include one fuel assembly, one UF6 cylinder, a tray of pellets prepared for loading into one fuel rod and several drums of UO2 powder with the same specifications. The term 'batch data' is defined at Article 2.11 of (Euratom) 302/2005 as 'the total weight of each category of nuclear material and, in the case of plutonium and uranium, the isotopic composition when appropriate. For reporting purposes the weights of individual items in the batch shall be added together before rounding to the nearest unit'.

2.6. ***Book inventory*** -Defined at Article 2.16 of (Euratom) 302/2005 as 'the algebraic sum of the most recent physical inventory of that material balance area, and of all inventory changes that have occurred since that physical inventory was taken.'

2.7. ***Category*** - For purposes of NMAS, nuclear material is assigned to categories. These are (Article 2.9 and Annex III of (Euratom) 302/2005):

Category	Isotopic Enrichment
D – Depleted Uranium (DU)	Uranium in which the percentage U-235+U-233 is less than that occurring in natural uranium
N – Natural Uranium (NU)	Uranium as it normally occurs in nature, containing nominally 0.711% U-235
L – Low Enriched Uranium (LEU)	Uranium having a U-235+U-233 content higher than natural uranium, but less than 20%
H – High Enriched Uranium (HEU)	Uranium having a U-235+U-233 content of 20% or greater
P – Plutonium (Pu)	All isotopes
T – Thorium (Th)	All isotopes in the form of metal/oxide, major constituent of an alloy or as concentrated intermediate/feed compounds
(D,N,L,H) Uranium 233	Uranium enriched in U-233 by weight in the same enrichment bands defined for U-235

2.8. ***Conditioned waste*** - Defined for Euratom safeguards purposes at Article 2.7 of Euratom) 302/2005 as 'waste, measured or estimated on the basis of measurements, which has been

conditioned in such a way (for example, in glass, cement, concrete or bitumen) that it is not suitable for further nuclear use.'

2.9. ***Containment*** - Defined for safeguards purposes at Section 2.1 of Recommendation 2009/120/Euratom as 'a structural feature of a facility, container or equipment which is used to establish the physical integrity of an area or item (including safeguards equipment or data) and to maintain the continuity of knowledge of the area or item by preventing undetected access to, or movement of, nuclear or other material, or interference with the contained items. Examples are the walls of a storage room or of a storage pool, transport flasks and storage containers.' The continuing safeguards integrity of the containment itself is usually assured by seals or surveillance measures, especially for containment penetrations such as doors, vessel lids and water surfaces.

2.10. ***Correction*** - Defined for safeguards purposes at Article 92(2) F of the UK/IAEA/Euratom voluntary offer Safeguards Agreement (INFCIRC/263) as 'an entry made in an accounting record or report to rectify an identified mistake or to reflect an improved measurement of a quantity previously entered in a record or report. Each correction must identify the entry to which it pertains'.

2.11. ***Corrective action*** - Defined for safeguards purposes at Section 2.2 of 2009/120/Euratom as 'action to eliminate the cause of a detected NMAC discrepancy, anomaly or other undesirable situation. Corrective action is taken to prevent recurrence. There is a distinction between correction and corrective action'.

2.12. ***Data processing*** - Defined in 2009/120/Euratom as 'is the link between the creation of measurement results and material-tracking data and the production of a variety of regulatory reports, documents supporting Euratom verification and internal working documents related to material tracking by the facility itself.

2.13. ***Decommissioned Installation*** - Defined for Euratom safeguards purposes at Article 2.24 of (Euratom) 302/2005 as 'an installation for which it has been verified that residual structures and equipment essential for its use have been removed or rendered inoperable so that it is not used to store and can no longer be used to handle, process or utilise source material or special fissile material.' The term 'closed-down installation' is defined for Euratom safeguards purposes at Article 2.25 of Euratom) 302/2005 as 'an installation for which it has been verified that operations have been stopped and the nuclear material removed but which has not been decommissioned.'

2.14. ***Discards*** (to the environment) - Defined for Euratom safeguards purposes at Article 2.8 of Euratom) 302/2005 as 'waste, measured or estimated on the basis of measurements, which has been irrevocably discarded to the environment as the result of a planned discharge.'

2.15. ***Discrepancy*** - The term 'NMAC discrepancy' is defined for Euratom safeguards purposes at Section 2.10 of 2009/120/Euratom as 'any discrepancy between two or more pieces of NMAC information (e.g. records) where this discrepancy cannot be justified after taking account of legitimate measurement variation or legitimate uncertainty estimation. NMAC discrepancies include measurement discrepancies, material balance discrepancies and nuclear material control discrepancies.' The term 'Nuclear Material Control Discrepancy' is defined for Euratom safeguards purposes at Section 2.12 of Commission Recommendation 2009/120/Euratom as 'a non-conformance in the identification or location of nuclear material'.

2.16. ***Effective kilogram*** - A special unit used in the safeguarding of nuclear material, reflecting its strategic value as defined at Article 2.13 of (Euratom) 302/2005:

a) for plutonium, its weight in kilograms;
b) for uranium with an enrichment of 1% (0.01) and above, its weight in kilograms multiplied by the square of its enrichment;
c) for uranium with an enrichment below 1% (0.01) and above 0.5% (0.005), its weight in kilograms multiplied by 0.0001; and

d) for depleted uranium with an enrichment of 0.5% (0.005) or below, and for thorium, its weight in kilograms multiplied by 0.00005.'

2.17. ***Emergency Physical Inventory Taking (EPIT)*** - A rapid stock take of nuclear material in response to the suspected loss, theft, or allegation of theft, the objective of which is to confirm or rule out the suspicions/allegations.

2.18. ***ENER*** - The EC Directorate General for Energy, which includes the nuclear accountants and safeguards inspectorate who discharge the EC's safeguards responsibilities under the Euratom Treaty.

2.19. ***Equivalence principle*** - The equivalence principle is a feature of obligation accountancy and provides that where nuclear material of a particular obligation loses its separate identity because of process characteristics (e.g. mixing), an equivalent quantity is designated as obligated nuclear material (on the basis that atoms or molecules of a substance are indistinguishable from another). The principle of equivalence does not permit substitution by a lower quality material, e.g. enriched uranium cannot be replaced by natural or depleted uranium. See also the principles of fungibility and proportionality.

2.20. ***Euratom regulation*** - EC Regulation (Euratom) 302/2005, which specifies Euratom safeguards reporting requirements.

2.21. ***European Safeguards Research and Development Association (ESARDA)*** - An association of European organisations (e.g. national regulatory authorities, operators of nuclear facilities and research centres and universities) involved in the research and development of nuclear safeguards (http://esarda2.jrc.it/about/index.html).

2.22. ***Facility*** - Defined for IAEA safeguards purposes at Article 92.(2)I of the UK/IAEA/Euratom Safeguards Agreement as 'a reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or any location where nuclear material in amounts greater than one effective kilogram is customarily used.' The term 'installation' as used for Euratom safeguards purposes (see below) differs by also including waste treatment and storage installations and locations with holdings of less than one Effective Kilogram of nuclear material.

2.23. ***Facility Attachment*** - A facility-specific part of the subsidiary arrangements to safeguards agreements with the IAEA which details how the reporting and inspection provisions of the agreement are to be applied at a particular facility or group of similar facilities.

2.24. ***Find*** - The discovery of a discrete item or items of nuclear material whose existence is previously unknown or unquantified – see Euratom safeguards reporting codes NM (New Measurement) and GA (Accidental Gain).

2.25. ***Fungibility principle*** - Uranium, in common with a number of other commodities, is 'fungible' in that, during processing, uranium from any source is identical to uranium from any other and it is not possible to differentiate, physically, the origin of the uranium. It is this fungibility that has led to the establishment and use of the principles of equivalence and proportionality.

2.26. ***GA (Accidental Gain)*** - Euratom safeguards reporting code – see Annex III of (Euratom) 302/2005.

2.27. ***Holdup*** - Nuclear material deposits remaining after shutdown of a plant in and about process equipment, interconnecting piping and adjacent areas. For plants in operation the Holdup is the amount of nuclear material contained in the process, and is also referred to as 'in-process inventory'.

2.28. ***Installation*** -Defined for Euratom safeguards purposes at Article 2.23 of (Euratom) 302/2005 as 'a reactor, a critical installation, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant, a separate storage installation, a waste treatment or waste

storage installation; or any other location where source material or special fissile material is customarily used'. This differs from the definition of 'facility' used for IAEA safeguards purposes (see above). The definition of 'installation' for Euratom safeguards purposes also differs from that for a 'nuclear installation' contained in the Nuclear Installations Act 1965.

2.29. ***International Atomic Energy Agency (IAEA)*** - An independent intergovernmental United Nations organisation which is, amongst other things, responsible for applying the international safeguards measures required by the Nuclear Non-Proliferation Treaty (NPT).

2.30. ***International Target Values (ITVs)*** -The International Target Values, issued under the auspices of the IAEA as document STR-327 of April 2001 and also available from ESARDA (esarda2.jrc.it/bulletin/bulletin_31/08.pdf), set out expected values for random and systematic measurement uncertainty components for destructive analysis (DA) and non-destructive assay (NDA) measurements performed on nuclear material. The values reflect what is regarded as achievable in the conditions normally encountered in industrial laboratories or during safeguards inspections. They do not represent the measurement uncertainties achievable under 'ideal' research laboratory conditions.

2.31. ***Inventory Changes*** - Defined for IAEA safeguards purposes at Article 92.(2)J of the UK/IAEA/Euratom Safeguards Agreement as 'an increase or decrease, in terms of batches, of nuclear material in a material balance area;

2.32. ***Inventory change increases***:

a) *Imports;*
b) *Receipts within the UK* - receipts from another UK nuclear sites, or from another material balance area on site, or from an activity not subject to safeguards under this Agreement, or at the starting point of safeguards;
c) *Nuclear production* - production of special fissionable material in a reactor;
d) *Accidental gains* - finds of nuclear material in plant areas where the presence of material is both unexpected and unusual; and
e) *New measurements (+ve)* – Inventory difference and new measurements which result in an apparent gain of nuclear material.

2.33. ***Inventory Change Decreases***:

a) *Exports;*
b) *Shipments within the UK* - shipments to another UK nuclear site or to another material balance area on site; or to an activity not subject to safeguards under this Agreement;
c) *Nuclear loss* - loss of nuclear material due to its transformation into other element(s) or isotope(s) as a result of nuclear reactions;
d) *Measured discard* - nuclear material which has been measured, or estimated on the basis of measurements, and disposed of in such a way that it is not suitable for further nuclear use;
e) *Retained waste* - nuclear material generated from processing or from an operational accident, which is deemed to be irrecoverable for the time being but which is stored;
f) *Accidental loss* - loss that is, irretrievable and inadvertent loss of nuclear material as the result of an operational accident or theft; and
g) *New measurement (-ve)* – Inventory difference and new measurements which result in an apparent loss of nuclear material.

2.34. ***Inventory Change Report (ICR)*** - A report that describes changes in the inventory of nuclear material in an MBA, and one of the accountancy reports (i.e. declarations) required by (Euratom) 302/2005 (its Article 12).

2.35. ***Inventory Difference (ID)*** - The difference between the Physical Inventory and the inventory indicated by the nuclear material accountancy system (book inventory). Also known as

'Material Unaccounted For' (MUF) and for which it should be noted that the Euratom convention (Physical Inventory – Book Inventory) is the opposite of the IAEA convention. Annual publication of Nuclear Material Balance figures for UK sites where civil nuclear material is processed includes information on Inventory Difference/Material Unaccounted For at the sites concerned.

2.36. ***Inventory Difference Action Level (IDAL)*** - The limit on an ID which, if exceeded, will require a special report to be made by the operator to the safeguards inspectorates.

2.37. ***Item*** - Defined for Euratom safeguards purposes at Article 2.10 of (Euratom) 302/2005 as 'an identifiable unit, such as a fuel assembly or a fuel pin.'

2.38. ***Key Measurement Point (KMP)*** - Defined at Article 2.15 of (Euratom) 302/2005 as 'a location where nuclear material appears in such a form that it may be measured to determine material flow or inventory, including but not limited to, the places where nuclear material enters, leaves or is stored in, material balance areas'.

2.39. ***Key Performance Indicator (KPI)*** - Metrics that may be used to monitor the effectiveness of a nuclear material accountancy system and nuclear operations – see Section 6 of this guidance. Section 2.15 of 2009/120/Euratom defines 'performance indicator' as 'a leading indicator of attainment achieved by an individual, team, organisation or an action.'

2.40. ***List of Inventory Items (LII)*** - See Physical Inventory.

2.41. ***Material Balance*** - The output from the process of comparing and reconciling the book inventory for a category of nuclear material and the amount of that material which is physically present. The balance for areas where material is processed may therefore include a statement of inventory difference (i.e. the amount of Material Unaccounted For, MUF). The term 'material balance test' is defined at Section 2.6 of 2009/120/Euratom as 'the method for assessing the material balance value; taking into account the justified estimation of measurement uncertainty, the balance test will decide whether the balance is acceptable or not.' The term 'material balance discrepancy' is defined at Section 2.7 of the recommendation as 'a material balance value which is not accepted by the material balance test'.

2.42. ***Material Balance Area (MBA)*** - Defined at Article 2.14 of (Euratom) 302/2005 as 'an area such that, for the purpose of establishing the material balance:

a) the quantity of nuclear material in each transfer into or out of each material balance area can be determined; and
b) the physical inventory of nuclear material in each material balance area can be determined when necessary in accordance with specified procedures.

2.43. ***Material Balance Report (MBR)*** - A report of the nuclear material in an MBA, facility, installation or other location where safeguarded nuclear material is stored or used, which shows aggregated transactions for the material balance period (e.g. year) in comparing the physical inventory with the book inventory.

2.44. ***Material Unaccounted For (MUF)*** - EC and IAEA terminology for an ID. The term is defined at Article 2.18 of (Euratom) 302/2005 as 'the difference between the physical inventory and the book inventory.'

2.45. ***Measurement Control Programme (MCP)*** - A system to ensure the effectiveness of measurement and analytical systems and the quality of resulting data that is generated for nuclear material accountancy and safeguards purposes (e.g. using ITVs to judge performance).

2.46. ***Ministry of Defence*** (MoD)

2.47. ***Near Real Time Material Accountancy (NRTMA)*** - A form of material accountancy for bulk handling facilities in which verification of flow is supplemented by physical inventories at

frequent intervals, e.g. weekly, through the use of in-process instrumentation (generally operator equipment) that does not interfere with process operations.

2.48. ***New Measurement (NM)*** - Euratom safeguards reporting code – see Annex III of (Euratom) 302/2005.

2.49. ***Non-Destructive Assay (NDA)*** - The measurement of the nuclear material content of an item without producing significant physical or chemical changes in the item. Non-Destructive Assay usually involves measurement of the radioactivity of the item for comparison with a calibration based on similar items whose nuclear material contents are very accurately known.

2.50. ***Non-Safeguarded nuclear material*** - Nuclear material that is excluded from the accountancy and safeguards requirements for reasons of national security and/or defence purposes. Accountancy requirements for such non-safeguarded nuclear material are specified by the Ministry of Defence (MoD), and are consistent with this guidance.

2.51. ***Nuclear Installations Inspectorate (NII)*** - Her Majesty's Nuclear Installations Inspectorate, the part of the Nuclear Directorate of the HSE responsible for regulating the licensing system for nuclear safety in the UK.

2.52. ***Nuclear material*** - Ores, source material or special fissile material as defined in Article 197 of the Euratom Treaty (see Annex I).

2.53. ***Nuclear Material Account*** – A group of debit or credits entries brought together under a specific heading to indicate an accounting condition (MBA, Accounting Area, Customer, material Type).

2.54. ***Nuclear Material Accountancy (NMA)*** - A system to register material quantities and locations, track items and quantities through transfers and processes, record measurement data, and provide information for reporting and analysis. The term 'Nuclear Material Accountancy and Control' (NMAC) is defined for Euratom safeguards purposes at Section 2.10 of 2009/120/Euratom as 'all activities in a nuclear installation concerning the accountancy and control of nuclear material, including the determination and processing of data and the reporting to the Commission.'

2.55. ***Nuclear material control account*** – An account which controls a number of other accounts. It contains the totals of debits and credits of a number of accounts to show at any time the balance of the aggregate of these accounts (eg site account).

2.56. ***Nuclear safeguards*** - Measures, including NMA, to verify that civil nuclear materials are properly accounted for and are not diverted to undeclared uses.

2.57. ***Nuclear Material Accountancy and Safeguards (NMAS) systems*** - The totality of operator measures for nuclear material accountancy to enable the implementation of nuclear safeguards.

2.58. ***Office for Civil Nuclear Security (OCNS***) - The security regulator for the UK's civil nuclear industry.

2.59. ***(Facility/Installation) Operator*** - The term 'Nuclear operator' is defined for Euratom safeguards purposes at Section 2.14 of Commission Recommendation 2009/120/Euratom as 'a person or undertaking setting up or operating an installation for the production, separation, reprocessing, storage or other use of source material or special fissile material. The term is also used to refer to the organisation ultimately responsible for NMAC compliance with Regulation (Euratom) No 302/2005.'

2.60. ***Ores*** - Defined for Euratom Treaty safeguards purposes (Article 197 of the Treaty) by Euratom Regulation No. 9 (February 1960) as uranium-bearing ores with an average concentration of 0.1 % or more uranium, thorium-bearing ores-except monazites with an average concentration of 3 % or more thorium and monazites with an average concentration of 10 % or more thorium or 0.1 % or more uranium.

2.61. ***Particular Safeguards Provisions (PSPs)*** - Specific requirements for the implementation of safeguards at a site or location within a site where safeguarded nuclear material is stored or used. These are drawn up by the EC using information provided in the BTCs and addressed to the operator, that take into account operational and technical constraints of application of the general provisions of (Euratom) 302/2005. PSPs together with the Regulation are the legal requirements of Euratom safeguards reporting. The equivalent in the IAEA system of safeguards is known as the Facility Attachment (FA).

2.62. ***Physical Inventory - Taking (PIT), Listing (PIL) and Verification (PIV)*** -
The ***Physical Inventory*** is defined at Article 2.17 of (Euratom) 302/2005 as 'the sum of all the measured batch quantities or derived estimates of batch quantities of nuclear material on hand at a given time within a material balance area, obtained in accordance with specified procedures'. The Physical Inventory is therefore as determined by the operator by means of a physical inventory taking (PIT), and defined at Section 2.16 of 2009/120/Euratom as 'the process to produce a complete list of the nuclear material items for an MBA as a basis for allowing verification of physical inventory by Commission inspectors'.

2.63. The results of the PIT must be reported to the safeguards inspectorates in the form of a ***Physical Inventory Listing (PIL),*** which lists all batches of nuclear material present at the time of the PIT. Requirements for provision of the PIL are as specified at Article 13 of (Euratom) 302/2005. The PIL is supplemented by detailed information in the form of a ***List of Inventory Items (LII),*** defined at Section 2.5 of 2009/120/Euratom as 'a complete list of nuclear material (NM) items in a material balance area (MBA) or a specified location within an MBA produced as a result of applying an installation procedure. The list may include material that is handled as a batch. The list should include the identities and locations of the items or batches. The mass values and other characteristics of the items or batches should be traceable.'
The PIT as recorded in the PIL and LII is verified by the safeguards inspectorates during a physical inventory verification (PIV) inspection, defined at Section 2.17 of 2009/120/Euratom as 'an inspection activity that verifies the validity of the operator's physical inventory taking and closes the material balance period. The basis for a PIV is the list of inventory items (LII) drawn up by the operator. The LII data are correlated with the physical inventory listing reports.'
The ending physical inventory for a material balance period is therefore the beginning physical inventory for the next material balance period.

2.64. ***Proportionality principle*** - The proportionality principle is a feature of obligation accountancy and provides that where obligated nuclear material is mixed with other nuclear material, and is processed or irradiated, a proportion of the resulting material will be regarded as obligated nuclear material to the same proportion as was obligated nuclear material initially.

2.65. ***Retained waste*** - Defined for Euratom safeguards purposes at Article 2.6 of (Euratom) 302/2005 as 'waste, generated from processing or from an operational accident, measured or estimated on the basis of measurements, which has been transferred to a specific location within the material balance area from which it can be retrieved.'

2.66. ***Safeguards agreement*** - An international agreement involving the IAEA which specifies the application of safeguards by the IAEA. So-called 'comprehensive' or 'full scope' such agreements are required of non-nuclear-weapon states (NNWS) under the Nuclear Non-Proliferation Treaty (NPT). The states defined as nuclear-weapon states (NWS) under the NPT, including the UK, have also agreed so-called 'voluntary offer' safeguards agreements in connection with the Treaty, which make some or all of their civil nuclear activities eligible for the application of IAEA safeguards. There are also safeguards agreements with the IAEA which predate and/or do not relate directly to the NPT, but provide for IAEA safeguards application to particular nuclear material and/or facilities (many of which are known as 'INFCIRC/66' type agreements).

2.67. ***Safeguards By Design (SBD)*** - to ensure that safeguards requirements are fully integrated into the design process stages (design, construction, commissioning, operation and decommissioning) and the project management structure from project inception.

2.68. ***Safeguards inspectorates*** - International nuclear safeguards are measures to verify that countries abide by their commitments to use nuclear material for declared peaceful purposes. The necessary international confidence is based on independent verification by the international safeguards inspectorates of the EC (currently part of the Directorate General for Energy , DG ENER) and the International Atomic Energy Agency (IAEA).

2.69. ***Safeguards obligations*** - Conditions on the use of nuclear material specified in the terms of inter-Governmental nuclear supply or co-operation agreements. See also Article 17 of (Euratom) 302/2005.

2.70. ***Seal*** - A tamper indicating device used to join movable segments of containment in a manner such that access to its contents without opening the seal or breaking of the containment is difficult. A sealing system comprises the containment enclosing the material to be safeguarded, the means of applying the seal (e.g. a metal wire) and the seal itself. All three components must be examined in order to verify that the sealing system has fulfilled its function of ensuring continuity of knowledge of the identity and integrity of the material concerned. See also containment.

2.71. ***Shipper/Receiver Difference*** (SRD) - Defined at Article 2.19 of (Euratom) 302/2005 as 'the difference between the quantity of nuclear material in a batch as measured at the receiving material balance area and the quantity as stated by the shipping material balance area.'

2.72. ***Small Holder of Nuclear Material (SHNM)*** - Those responsible for nuclear material which is not at licensed nuclear sites but is nevertheless subject to the safeguards requirements of the Euratom Treaty, for example:

a) universities, colleges and research institutes that use nuclear material for academic studies;
b) analytical laboratories that use nuclear material as reference sources;
c) manufacturers of measurement instruments that use sealed sources as standards for calibration and/or who use plutonium, enriched uranium or uranium-233 in gram quantities or less as sensing components in instruments (e.g. for fission chambers or smoke alarms);
d) organisations that use depleted uranium, natural uranium or thorium in exclusively non-nuclear activities (e.g. as radiation shielding, including depleted uranium transport containers for medical or industrial radioisotopes, as ballast/counterweights, as high hardness alloys of the kind used in aerospace applications, as catalysts for use in the chemical industry or as pigments in glass); and
e) organisations with inventories of plutonium which has an isotopic concentration of plutonium-238 exceeding 80%.

2.73. ***Source data*** - Defined at Article 2.20 of (Euratom) 302/2005 as 'those data, recorded during measurement or calibration or used to derive empirical relationships, which identify nuclear material and provide batch data, including: weight of compounds; conversion factors to determine weight of element; specific gravity; element concentration; isotopic ratios; relationship between volume and manometer readings; and relationship between plutonium produced and power generated'.

2.74. ***Source materials*** - Defined at Article 197 of the Euratom Treaty as 'uranium containing the mixture of isotopes occurring in nature; uranium whose content in uranium 235 is less than the normal; thorium; any of the foregoing in the form of metal, alloy, chemical compound or concentrate; any other substance containing one or more of the foregoing in such a concentration as shall be specified by the Council, acting by a qualified majority on a proposal from the Commission.' Definition of the term 'source material' at Article XX of the IAEA Statute is essentially the same.

2.75. ***Special fissile materials*** - Defined at Article 197 of the Euratom Treaty as 'plutonium 239; uranium 233; uranium enriched in uranium 235 or uranium 233; and any substance containing one or

more of the foregoing isotopes and such other fissile materials as may be specified by the Council, acting by a qualified majority on a proposal from the Commission; the expression special fissile materials' does not, however, include source materials.' Definition of the term 'special fissionable material' at Article XX of the IAEA Statute is essentially the same.

2.76. ***State (or Regional) System of Accountancy and Control (SSAC)*** - Organisational arrangements to account for and control nuclear material in a state or region and thus provide the basis for application of IAEA safeguards – and as such a requirement of safeguards agreements with the IAEA. The EC fulfils the role of SSAC for the UK/IAEA/Euratom voluntary offer safeguards agreement.

2.77. ***UK Safeguards Office (UKSO)*** - Operational aspects of safeguards implementation in the UK were transferred to the Nuclear Directorate of the HSE, on 1 April 2007. UKSO's role is to work with the safeguards inspectorates and the UK nuclear industry to ensure that the UK's safeguards requirements are met in a proportionate manner.

2.78. ***Waste*** - Defined at Article 2.5 of (Euratom) 302/2005 as 'nuclear material in concentrations or chemical forms considered as irrecoverable for practical or economic reasons and which may be disposed of.' Section 2.5.2.1 of the EC Recommendation (2006/40/Euratom) which provides guidance on aspects of the implementation of Regulation 302/2005 states that Euratom safeguards can be terminated on waste containing very low concentrations of nuclear material as indicated below:

Depleted and natural uranium	1,000 g/tonne
Low enriched uranium	200 g/tonne
High enriched uranium	10 g/tonne
Plutonium	4 g/tonne