SAT integrated

- **PR parameters**
  - Legal Framework
    - Compliance with international non-proliferation treaties
      - Regional treaties
        - Euratom
      - NPT
        - CSA
        - AP
    - inspectorate's resources
      - Available resources
      - Resources to allocate are comparable to similar facilities (DE)
    - country specificities
      - Import/export control
        - NSC
        - Zanger commitee
      - historical violations
        - yes
        - no
  - Material characteristics
    - Material quantity
    - Material quality
- **Safeguards**
  - Design information
    - Design information collection
      - Fuel cycle characterisation
        - Th-U
          - the design allows for U-233 breeding through decay of Pa-233 outside the reactor core
        - U-Pu (Pu started)
          - Pu quality
        - U-U
          - LEU
          - HALEU
        - the design allows fuel cycle switching
          - Are the timeliness objectives consistent when switching cycle?
        - The design introduces material of a lower SQ or timeliness objectives
      - The design does breeding through a fertile blanket (DIV.1)
        - check dependencies THROUGHOUT THE BOARD
      - Different steps of the fuel cycle are included on the facility
        - the design allows for onsite fuel reprocessing capabilities
          - Fissile material separation capabilities
            - Online chemical separation unit
              - Is it within containment
              - Is it automated
          - Fission product removal
            - rare earth
            - noble metal
            - gas
    - DIV
      - The design can be readily and easily verifiable
        - Inspector Accessibility
          - Inspector Accessibility during construction
          - Inspector Accessibility during operation
          - Inspector Accessibility during decommissioning
        - adequate tools available for supporting activities (e.g. robot inspection)
          - state of the art technology for the verification of design changes can be applied
      - The facility cannot be easily modified
        - The facility employs automation
          - False alarms are low while maintaining high safeguardability
    - The design's impacts on the diversion paths
      - does it increase the difficulty of the IAEA inspectors activities?
        - Commercial or security sensitivities
        - New or modified tech
        - access to instrumentation for testing
        - limitations on the IAEA's verification activities during the life of the facility
      - Does this design create new or alter existing opportunities for facility misuse
        - Opportunities for undeclared irradiation of nuclear material
        - Opportunities for working towards a WG material
        - Opportunities for undeclared irradiation of nuclear material
      - is there the potential to create additional diversion paths or alter existing diversion paths?
        - Barriers to NM removal
      - does the design make detection of misuse more difficult
        - Effectiveness of inspections
        - transparency of operations
  - NMAC
    - Nuclear Material and instrumentation (PIV's effectiveness)
      - EP3.1.2 Inspector measuring capabilities (what means can the inspector use? NMA.1)
        - NDA
          - The NM can be accurately qualified/quantified
            - The design enables different measuring techniques to complete each other (reverification and robustness of the system)
              - The NM possesses an informative neutron signature
                - correlated neutrons are an informative signature
                - passive assay
                - need for information about SF-emitting isotopes
                - even isotopes of Pu (that have high SF probabilities) are present
                - The Cm/Pu ratio is known
                - active interrogation
                - need for info about fissile isotopes mass/quantities
                - need for a low neutron environment so that the results of active interrogation are measurable
                - need for a neutron source
                - criticality risk assessed through SBD
                - The added-value of using an active interrogation technique has to be adequate (much more precise, time-efficient, or practical) to justify the management of the radiosource
                - self-interrogation
                - need for information about fissile isotopes other than Pu
                - Presence of (alpha, n) reactions that create random neutrons (non correlated)
                - Need for alpha-emitting material
                - Need for light elements for undergoing (alpha, n) reactions
                - The interrogant neutrons have to be thermalised and reflected into the item
                - needs suitable geometry and surroundings
                - The signature is not hidden by the 242Cm SF
                - total neutrons are an informative signature
                - Differential Die-Away (active measurement)
                - pulsated neutron generator can be used (different from the active interrogation's because, there, the source can be any neutron source, and you have only one source, no dependency)
                - criticality risk assessed through SBD
                - The added-value of the use of an active interrogation technique justifies the complications tied to the neutron generator (much more precise, time-efficient, or practical)
                - fissile (uneven) isotopes presence
                - total neutron counting (passive measurement)
                - need for info about the irradiation history (which can inform us about the supposed composition of the item)
                - even isotopes presence
              - The NM possesses an informative gamma signature
                - The shielding is compatible with the use of gamma detectors (NMAC.11)
                - The shielding does not prevent the measurement or, if the NM is shielded in a way that prevents measurements, adequate penetrations are foreseen
                - representativeness of the measurement is acknowledged (penetrability of the signal in the assayed material)
                - The gamma measurement can be interpreted (NMAC.12)
                - U-235, Pu, FP peaks in the spectra can be related to irradiation history
                - The spectra can be deconvoluted
              - The NM possesses an informative calorimetry signature (NMAC.13)
                - decay heat is measurable (NMAC.14)
                - The assayed material is static
                - Decay heat can be linked to the NM composition (NMAC.15)
                - Heat linked to the composition of the SNF
                - Heat generated by Alpha decay linked to the actinides' mass on fresh fuel
            - The design allows the instruments' characteristics to be appropriate for the needed measurements
              - The NM quantity and geometry allows the instrumentation to detect partial defects (NMAC.14)
                - The design characteristics (e.g. piping thickness tied to the operative pressure) do not affect the measurement accuracy at KMPs
                - The shielding does not degrade the measuring capabilities beyond the ITV (signal is too weak or too strong)
                - quantities lower than 1 SQ or less than an item are detectable
                - 0.82cm (<1cm) of lead thickness for reducing the intensity of the signal by half for Cs-137 (of which the signal is stronger by a factor of 10^5)
                - Dead-time effect
                - The radiation does not limit the instrumentation operational life (beyond what is reasonable for resource efficiency)
                - Sensitive electronics can be shielded while the detectors remain exposed
                - The form/chemical/isotopic of the material does not impact the measurements at KMPs (NMAC.19)
                - quantities lower than 1 SQ or less than an item are detectable
                - The materials/detectors employed for the measurement are adapted to the temperature
                - The temperature does not represent a biais in measurements (constant temperature and thermal shileding/isolation) or it is taken into account (inclusion of a temperature monitor in the design through a SBD process)
                - The materials employed for the measurement are adapted to the corrosivity of the measured medium (a corrosion resistant surface must be included in the detector's design)
                - Given a measurement accuracy, the throughput of NM is compatible with the detection goals
                - There is a flow measurement device or a built-in accountancy tank
                - quantities lower than 1 SQ or less than an item are detectable
                - If the throughput is too high to reach the detection objectives, separation into multiple streams is done
            - The design enables the instruments to be kept in the best working conditions
              - Calibration of NDA instruments can be done independently by the inspecto, or verified after the manufacturer's calibration (eg: hot cells accessibility)
                - The instruments are accessible by the inspector (direct or Remote handling)
                - There is a benchmarking sample available for calibration
              - no interference with Cherenkov light measurements
              - The (SNF) pools' water is kept clear
          - The NM in the facility is accurately modeled (by the operator and verifiable by the inspector)
            - MUF is reduced and within the inspectorate's objectives
              - MUF uncertainties are accurately estimated
                - The uncertainties are within the allowed range
                - Pu or U sigma(MUF)/SQ
                - MUF estimations can be reproduced independently
              - MUF is reduced as much as possible
                - Hold-up can be calculated at any point in time (between cleaning actions)
                - The design does not create potential for hidden inventory
                - Hidden-inventory is reduced, calculated, and stable
            - Burnup models are independently benchmarked
            - The fissile material evolution is modeled
              - The removal rate of fissile isotopes in the online fissile material separation is modeled
                - The inspector can verify/reproduce independently the models
              - the addition of fissile fresh fuel through onload fresh fuel top ups is modeled
                - The inspector can verify/reproduce independently the models to prove that no diversion has occurred
              - The addition rate of bred fertiles from the blanket to the core is modeled
                - The inspector can verify/reproduce independently the models to prove that no diversion has occurred
              - The radioactive decay is modeled
                - The radioactive decay in the core is modeled
                - The radioactive decay in reprocessing units is modeled
                - The radioactive decay in the storage is modeled
            - FP evolution is accurately modeled
              - The design's FPs removal is modeled
                - The design's noble metal removal is modeled
                - The inspector can verify/reproduce independently the models to prove that no diversion has occurred
                - The design's gas removal system is modeled
                - the gaseous products removal does not separate fissile material
                - The inspector can verify/reproduce independently the models to prove that no diversion has occurred
                - The design's rare earth removal is modeled
                - The inspector can verify/reproduce independently the models to prove that no diversion has occurred
              - The FPs accumulation is accurately modeled
                - The noble metals plating and accumulation is modeled (in elements such as filters
                - The rare earth plating and accumulation is modeled (in elements such as filters
        - DA
          - Samples can be directly and independently analysed at any time (Is there an onsite lab?)(NMAC.21)
            - radiation is managed at any time
      - measuring possibilities (The NM in the facility is measurable (=I measured))
        - The NM is accessible for verification
          - fresh fuel is accessible for verification (NMAC.)
          - irradiated fuel is accessible for verification
            - in-core verification capability (NMAC.)
            - spent fuel is accessible for verification (NMAC.)
          - MUF is reduced ALARP
            - Hold-up inventory
              - Hold-up is measurable
            - Hidden inventory
              - Hidden-inventory is measurable
        - Samples can be colleted for DA measurement
          - Samples can be colleted for DA measurement at any time (NMAC.20)
            - radiation is managed during inspections
            - The material is homogenous
    - Design impact on the PIV's efficiency
      - Item is always preferred to bulk when possible
      - The accountancy system is defined throughout the facility
        - There is a minimum number of MBAs (NMAC.)
          - The boundaries between the MBAs (physical or not) are clearly defined (NMAC.)
            - The CoK between the MBAs is maintained
          - The accounting method takes into account the transition between MBAs (NMAC.)
          - The design does not impact KPM establishment (NMAC.)
            - Provision for installing the NDA instruments
        - The sampling/measuring scheme is fit-for-purpose (NMAC.)
          - the uncertainties from sampling/measuring only a portion of the NM are done according to international best practices
          - The used instrumentation is fit-for-purpose (resolution and efficiency are adequate)
            - reduced DE requires justification (e.g. use of microcal instead of cheaper detectors)
        - shared equipment and joint effort makes for a cheaper and more adapted safeguards system
          - provision for instruments installation (NMAC.)
          - provision for data sharing and verification (NMAC.)
          - The instruments are periodically calibrated by the operator
            - Calibration can be done or verified independently
        - near real time NMAC can be established (NMAC.)
          - process monitoring implemented
            - Reactor operation temperature can be monitored to detect diversion through a decreased reactivity
            - Fuel salt composition monitoring
          - refer to "shared equipment"
      - NM is directly accessible for verification (no need for moving the NM for measurement due to stacking for instance)(NMAC.18)
        - radiation is managed during inspections
      - Movement of NM between PIT and PIV is precluded or limited (NMAC.22)
      - When absolutely necessary, PIVs match as much as possible already planned downtimes
        - the frequency at which components are replaced is defined
          - the replacements are scheduled
  - C/S
    - Containment
      - Structural
        - Structural containment is designed not to be altered
      - Seals
        - Seals are protected from accidental damage
        - All NM can be verified and sealed
        - The seals are accessible for verification
        - Radiological hazard that poses accessibility challenges make containment easier
    - Surveillance
      - The need to move the NM is minimised
      - Surveillance and/or RM can be applied
        - Surveillance can be applied
        - RM can be applied
      - Illumination according to requirements
    - Accomodation for C/S
      - Accomodation for C/S equipment
        - Mounting spaces
        - Wiring
        - Reliable current supply
        - Transmission of data
      - Material transfers are easy to monitor
        - movements of NM are organised in batches (or items)
        - movements of NM are standardised
        - movements paths and frequencies are standardised
        - Automation of C/S equipment

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