EURAMET | EMRP European Metrology Research Programme ● Programme of EURAMET | Call 2010 JRP13i:

MetroMETAL

Ionizing Radiation Metrology for Metallurgical Industry

SUMMARY:
- Foundries produce yearly millions tons of steel that can be potentially contaminated by smelting radioactive sources hidden in scraps. Undesirable consequences are contamination of cast metal, furnaces, slags, the environment and also the accidental irradiation of population with expensive costs and strong international impact.
- Current radioassay controls do not guarantee appropriate traceability and therefore the proposed JRP will address an European-harmonized action to configure appropriate instruments, develop reference materials and issue measurement procedures and technical standards for SI-traceable radioactivity monitoring of scrap, slag, fumes dust and cast steel, in order to prevent contamination effects, population hazards and trade disputes, leading to uniform application and technical acknowledgment across Europe and worldwide.
- The project is a sound concept, being developed by a consortium of 14 National Metrology Institutes which guarantees the application of the highest metrological knowledge on measurements in this field.

THE PROCESS (WHAT)

THE WORK TO DO (HOW)

WP1: Improvement of methods and devices for measurement of activity of radionuclides in metallurgy (CMI, CIEMAT, ENEA, ITN, POLATOM, PTB, SMU, STUK)

Task 1.1: Improvement of testing methods for gate scrap monitors (CMI, CIEMAT, ENEA, ITN, POLATOM, PTB, SMU, STUK)
Task 1.2: Design of reference spectrometric device for cast steel and slag samples measurement (CMI, CIEMAT, ENEA, ITN, POLATOM, PTB, SMU, STUK)
Task 1.3: Development of balance sampling method and laboratory analysis for fumes dust measurement (CMI, CIEMAT, ENEA, ITN, POLATOM, PTB, STUK)

WP2: Development and characterisation of standard reference sources (PTB, CEA, CIEMAT, CMI, ENEA, IFIN-HH, JRC, POLATOM, SMU)

Task 2.1: Development of composite cast steel reference standards (CMI, CIEMAT, ENEA, JRC)
Task 2.1: Development of composite cast steel reference standards (CMI, CIEMAT, ENEA, JRC, PTB)
Task 2.3: Development of slag reference standards (CIEMAT, CEA, ENEA, IFIN-HH, JRC, POLATOM, PTB)
Task 2.4: Development of fume dust reference standards (PTB, CEA, JRC, POLATOM)

WP3: Characterization of measurement geometries and reference sources by measurement, simulation and intercomparisons (CMI, all)

Task 3.1: Type Monte Carlo model of a device for measurement of cast steel, slag and fume dust samples (ITN, all except IJS)
Task 3.2: Methodology and calculation of true coincidence summing corrections of cast steel, slag and fume dust samples (CMI, CEA, CIEMAT, ENEA, ITN, JRC, PTB, SMU, STUK)
Task 3.3: Inter-laboratory comparison of reference materials (JRC, all)

WP4: Improved measuring instrument adapted to measurements of cast steel and slag probes (CIEMAT, CMI, PTB, ENEA, SMU)

Task 4.1: Detail design of an instrument with improved response (CIEMAT, CMI, SMU)
Task 4.2: Determination of the instrument response by Monte Carlo calculation (CIEMAT, CMI, ENEA, SMU)
Task 4.3: Algorithms for spectra analyses (ENEA, CIEMAT, PTB, SMU)
Task 4.4: Construction of a prototype of an improved instrument adapted for the measurement of probes of cast steel and slags (CIEMAT, PTB, SMU)
Task 4.5: Testing the instrument at laboratory (CIEMAT, PTB, ENEA)

WP5: Experimental verification and demonstration at end user facilities (foundries and regulatory bodies) (IJS, CIEMAT, BEV, CMI, ENEA, IFIN-HH, POLATOM, SMU).

Task 5.1: Specification of verification methods, procedures and criteria for measurement devices selected for verification. Establishment of verification environment. (ENEA, IJS, CIEMAT, SMU, BEV, POLATOM)
Task 5.2: Experimental verification of measurement devices and measurement procedures (CIEMAT, IJS, SMU, BEV, ENEA, POLATOM)
Task 5.3: Demonstration at end-user facilities (IJS, CIEMAT, SMU, BEV, ENEA, IFIN-HH, POLATOM, CMI, ALL)

WP6: Creating Impact (BEV, all)

Task 6.1: Organization of JRP workshops (CIEMAT, all)
Task 6.2: Organization of scientific visits (ENEA, all)
Task 6.3: Publications in peer-reviewed journals (PTB, all)
Task 6.4: Scientific contribution to Conferences and Working Groups (CEA, all)
Task 6.5: JRP website setup (CIEMAT, BEV, all)
Task 6.6: User group and email list setup (CIEMAT, all)
Task 6.7: Co-ordination of comparison exercises / proficiency tests (CMI, all)
Task 6.8: Contribution to metallurgical industry guidelines (CMI, all)
Task 6.9: Stakeholder involvement (BEV, all)

WP7: JRP Management and Coordination (CIEMAT, all)

- Project Management Board (PMB) + General Project Meeting (GPM) + inter-partners information exchange
- Team structure: Coordinator (& WP7 Leader): José M. Los Arcos (CIEMAT)
  WP1 Leader: Vladimir Sochor (CMI); WP2 Leader: Dirk Arnold (PTB); WP3 Leader: Jaroslav Solc (CMI)
  WP4 Leader: Eduardo García-Toraño (CIEMAT); WP5 Leader: Branko Vodenik (IJS);
  WP6 Leader: Franz-Josef Maringer (BEV); WP7 Leader: José M. Los Arcos (CIEMAT)

Task 7.1: Management and coordination activities (CIEMAT, ALL)

SCIENTIFIC EXCELLENCE (technical WHY)

THE NEED:

- Radioactive contamination events due to hidden sources (Spain 1997, Finland 2006, ...?) mainly ^{60}Co or ^{192}Ir sources from radiotherapy, brachytherapy or gammagraphy in scrap loads,
- Negative consequences: furnaces damaging, contamination of cast steel slags, filters, irradiation of end users, trade disputes on contamination levels of products, financial impact on market, loss of reputation of metallurgical companies,
- both "a priori" and "a posteriori" controls needed.
- "Recommendations on monitoring and response procedures for radioactive scrap metal" (United Nations Economic Commission for Europe, 2006), recommends the "Establishment of a voluntary international "Protocol" providing for a consistent and internationally harmonized approach to monitoring procedures",
- "Spanish Protocol for Collaboration on the Radiation Monitoring of Metallic Materials (MINER, Spain, 2005), (considered a model to be followed).
- European Commision is about to publish a new Regulation on "establishing the criteria determining when certain types of scratch metal cease to be waste under Directive 2008/98/EC ...".
- National legislations ongoing in European countries: need for harmonization of technical procedures and reference measurements.
- Specific interest of 22 stakeholders (nuclear/radiation regulatory authorities, steel associations, steel producers) on this JRP (see below "WHO")

BEYOND THE STATE OF THE ART BY:

- developing new reference materials, conveniently traced to SI units (non existing at present),
- designing an improved measurement instrument adapted to this work, for high-level performance of controls,
- developing technical procedures and standards proposals for European & worldwide application,
- demonstrating and training users in the new developments.

STOs OF JRP13i: (in full agreement with SRT13i STOs, see on the right ! →)

- Design of overall standardised traceable measurement methods, optimized for control/measurement of scrap loads, metal products, slag and fumes dust, according to the EC, national regulations and to NEA and IAEA recommendations.
- Development of standard reference sources for cast steel and slags at the contamination threshold levels for:
  - potential contaminant radionuclides (60Co, 137Cs, 192Ir, 226Ra, ...),
  - different steel compositions, black and grey slags, fumes filters,
  - different sample geometries, matching the cast steel probes currently used for on-line measurements and the slag cartridges needed for calibration of detectors.
- Characterization of reference sources by combined measurement-simulation methods and inter-laboratory comparisons.
- Optimized setup of reference measurement system(s), based on spectrometric systems with NaI, HPGe, plastic scintillation detectors or other appropriate sensitive devices.
- Development of technical procedures for scrap controls, calibration of measurement systems and on-line radioassay controls.
- Development of measurement, evaluation, calibration and control software.
- Demonstration, testing and users training actions at selected foundries in Europe.
- Dissemination of results and knowledge to stakeholders, end users and to the scientific community.
- Development of recommendations leading to technical standardization of calibration of measurement systems, on-line monitoring of production and final certification of cast steel batches with technical acknowledgment all around Europe and third countries.

RELEVANCE TO EMRP OBJECTIVES (eligibility WHY)

CONFORMITY WITH EMRP GENERAL OBJECTIVES:

EMRP Outline 2008 extracts:
1) I.1 Activity areas: Ionising radiation
The main objectives are concentrated on health and industrial applications ...
The main activities to develop are:
- Realization of new devices for the traceable characterisation of radiation sources.
2) I.1.1 Grand challenge: A key challenge facing the EU is the need to ensure continuous and sustainable growth whilst reducing negative environmental impacts. ...measuring flow and concentration of species under regulation, efficient and sustainable use of resources, validation of traceable measurement techniques.
3) I.1.1 The global challenge for metrology:
Industry, trade, and increasingly quality of life depend on precise, reliable and comparable measurements. Therefore the demands on metrology are steadily growing, and can be expected to grow even more rapidly in the future. The drivers behind this pressure may be considered threefold: ... traditional areas of industry are becoming more complex and are requiring broader measurement ranges and lower uncertainties;
4) I.1.5 Grand Challenge: A key challenge facing the EU is the need to ensure continuous and sustainable growth whilst reducing negative environmental impacts. Minimising future negative environmental impacts depends on the implementation of policies that encourage the sustainable use of energy and resources, improving the quality of life for European citizens by:
- improving measurements standards for flow and for the detection of bio and chemical releases into the environment.
5) II.6.2 Focused single discipline and applied metrology:
- Innovative setups for new industrial and societal needs
In aerospace, aeronautics, production, transport or process controls, measurements are generally performed under dynamic conditions and often by use of automated systems. ... The proposed research aims to reinforce the leading position and competitiveness of the European industry in that field.

CONFORMITY WITH THE SRT13i STO:

This JRP fully address ALL the scientific and technical objectives (STOs) stated in the selected research topic SRT13i:

Scientific and technological Objectives in SRT13i:	Addressed by JRP13i in:
1) Design of overall standardised traceable measurement method for control/measurement of scrap, metal products, slag and gaseous discharges according to the EC, national regulations and to NEA and IAEA recommendations.	WP1
2) Development of standard reference sources for cast steel and slag at the contamination threshold levels for: a. potential contamination radionuclides (EGCs, 137Cs, 192Ir, 226Ra, ...), b. different steel compositions, c. different sample geometries suitable for on-line measurements.	WP2
3) Characterization of reference sources by combined measurement-simulation methods and inter-laboratory comparisons.	WP2, WP3
4) Development of reference measurement system(s) (NaI, HPGe, plastic scintillation detectors, ...).	WP3, WP4
5) Development of technical procedures for calibration of measurement systems and on-line radioassay controls.	WP1, WP4
6) Development of measurement, evaluation, calibration and control software.	WP4
• Proposers shall give priority to work that meets documented industrial needs and that which supports transfer into industry e.g. by cooperation and/or by standardisation.	WP5, WP6, WP7
• Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.	Sections B.1.a, B.1.b

IMPACT (TO WHOM)

- directly, in the basic sector of Metallurgical Industry (sector #3 of EMRP Call "Industry"),
- in second place, in the sector of Process Engineering and Production Technologies (sector #4).

Industrial impact: Making available more accurate measurement methods it is estimated that extra costs derived from false alarms triggering will reduce from 3% to <1 % of cases

Standardization impact (on EC Directives and relevant standards):
- The availability of technical procedures, certified reference materials and a harmonized EN/ISO technical standard for cast steel certification would bring the basic production sector of steel foundries into the range of applications of ionizing radiations metrology.
- European Commision is about to publish a new Regulation on "establishing the criteria determining when certain types of scratch metal cease to be waste under Directive 2008/98/EC ...".

Safety/Social impact: With accurate radioassay methods and metrologically calibrated measurement instruments, the risks of irradiation will decrease significantly and savings in medical treatments could be estimated around 10 M€ for a single contamination event.

Environmental impact: The availability of traceable metrological methods will introduce objective decision procedures that will help avoid the environmental contamination.

Financial impact: Return of contaminated loads to sender must be done by specialised carriers with costs as high as € 120000 per typical container, of 20 tonnes, with tens of positive detections each year.

WHO

RESOURCES (person.month)

	1 CIEMAT	2 BEV	3 CEA	4 CMI	5 ENEA	6 IFIN-HH	7 IJS	8 ITN	9 JRC	10 NPLUS	11 POLATOM	12 PTB	13 SMU	14 STUK	TOTAL
WP1	4			13	6			5			1	4	3	3	39
WP2	7		9	4	6	11			4		4	25	3		73
WP3	6	2	8	10	6	12	1	15	6	3	2	11	3	2	91
WP4	18			4	7							4	4		37
WP5	3	3		2	5	2	3				1		3		22
WP6	3	5	1	2	1	1	1	2	1	1	1	2	1	1	23
WP7	14	1	1	1	1	1	1	1	1	1	1	2	1	1	29
TOTAL	57	11	19	36	32	27	6	23	14	5	10	48	18	7	313

BEV | CEA Laboratoire National Henri Becquerel LNE-LNHB | Ciemat | CMI | ENEA | IFIN-HH | Institut Jožef Stefan | itn | JRC IRMM | PTB | SMU | STUK