Challenges in implementing the change in regulations in the NORM industry

Rafael García-Tenorio
Universidad de Sevilla

CONTENT

It seems evident that the revised BSS would provide greater clarity on the control of exposure to natural sources although their application will be far to be trivial, still remaining some complexities.

The description and evaluation of some important challenges, in relation with the implementation of the new BSS in the NORM industries will be form the core of this keynote lecture.

INTRODUCTION: Some history….

It was about twenty years ago when some countries, mostly European, started to introduce measures to regulate exposures arising from natural sources, in particular from minerals other than those associated with the extraction of uranium.

Two important milestones in this regard were the establishment of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (IAEA, 1996) and the European Council Directive 96/29 of Euratom published the 13 of May 1996.

Both contain provisions for protective measures against significantly increased exposures of workers and members of the public to natural sources.

THE NORM CONFERENCES

Amsterdam. The Netherlands (1997)

Krefeld, Germany (1998)

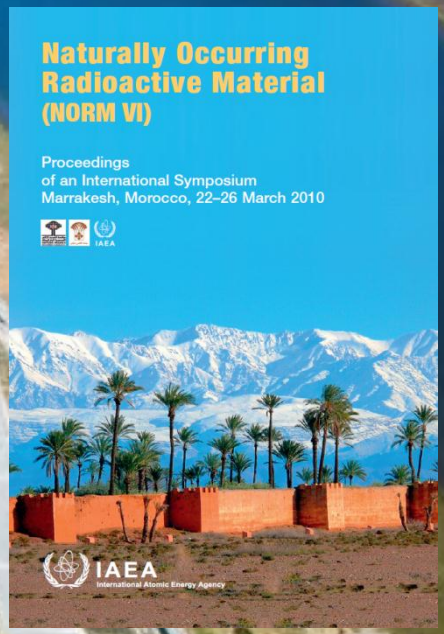
Brussels, Belgium (2001)

Szczyrk, Poland (2004)

Seville, Spain (2007)

Marrakech, Morocco (2010)

Beijing, China (2013)



Procceedings:
Perfect archives showing the evolution and the increasing harmonization in the subject

The beginnings….

The beginnings were quite far to be easy. Only one year after the publication of the European Directive, the first NORM Conference was held in Amsterdam due to the concern generated in the European chemical industry about its implementation.

The novelty of these regulations,
The lack of experience of all the actors involved,
The confusing treatment of some key points of the international standards,

→ a certain chaos during the first few years.

It was the time where misunderstandings in the interpretation of several requirements of the BSS were no unusual, and where a tendency for overregulation was evident due to the no application of the principle of graded approach.

Along the time ……

From 1996 until now, the advances in the Radioprotection in NORM have been evident, acquiring the issue a worldwide dimension not existing twenty years ago.

New regulations for the control of exposures to NORM become established and the knowledge about levels of exposure has clearly improved.

Nevertheless, all the controversial aspects have not disappeared

NORM V Conference Seville, Spain 2007 → there was a chaos or consensus in relation to managing NORM? → There was still a little of both

Perception ……

Although in less extent along the time, a perception in the community involved in the NORM issue is that the treatment of exposure to natural sources in international standards has been unnecessary complicated and confusing, inducing misunderstandings and differences in their interpretation, mainly in basic and essential concepts.

THE NEW BSS

Only some few months ago were definitively published the new version of the International Basic Safety Standards (BSS) which replaced the published ones in 1996.

The requirement in the new BSS are in line with the 2007 Recommendations of the ICRP.

Three types of exposure situations (planned exposure situations, existing exposure situations and emergency exposure situations) are reflected in the structure of the new BSS.

Exposure to natural sources continues to be generally subject to the requirements for existing exposure situations, but exposure control, is based on the use of the so called reference levels.

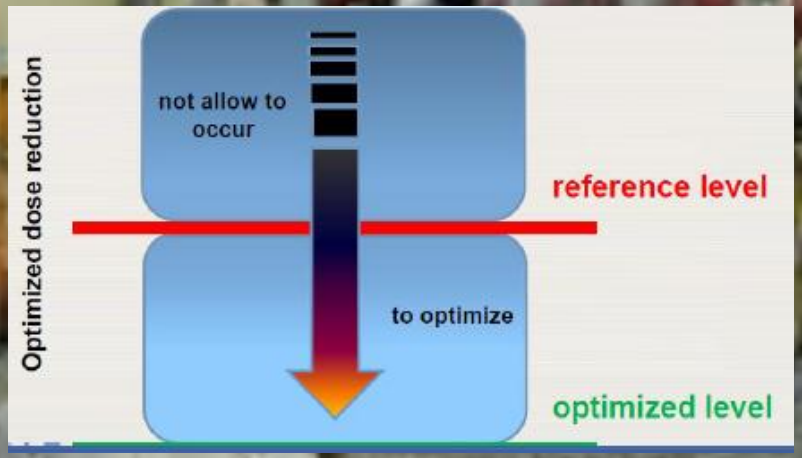
Reference levels replace the concept of “action levels” included in the old BSS

Planned vs. Existing

Exposures subject to the requirements for existing exposure situations	Exceptions (subject instead to the requirements of planned exposure situations)
Exposure for radionuclides from residual radioactive material for unregulated or inadequately regulated past activities	No exceptions
Exposure to radionuclides in everyday commodities, i.e. food, feed, drinking water, fertilizer, soil amendments, construction materials	No exceptions
Exposure to radionuclides in material other than everyday commodities	An exception applies if the radionuclide concentration exceeds 1 Bq/g (U, Th series)or 10Bq/g (^{40}K). The exception also applies to public exposure toi discharges and waste from the facilities concerned, irrespective of their activity concentrations.
Public exposure to ^{222}Rn, ^{220}Rn and progeny indoors	No exceptions
Occupational exposure to ^{222}Rn, ^{220}Rn and progeny indoors	An exception applies if: a) Exposure to other U, Th series radionuclides is controlled (as a planned exposure situation); or b) ^{222}Rn concentrations remain above the reference level after remedial action

Reference levels

Reference levels are levels above which it is inappropiate to plan to allow exposures to occur, and below which optimization of protection should be implemented.



Reference levels are not the same as action levels

Action levels are levels at or below which remedial action (and thus the need for optimization) is no normally necessary.

Existing exposure situations

Reference levels

- The relevant national authority shall establish reference levels
- Optimized protection strategies shall be implemented with the objective of reducing doses to below the reference level.
- Exposures below the reference level shall not be ignored

The reference level … shall typically be expressed as an annual effective dose to the representative person in the range 1–20 mSv or other equivalent quantity :activity concentration per unit mass, unit volume or unit surface area as appropriate

Radon: ≤300 Bq/m^3 in homes, ≤1000 Bq/m^3 in workplaces. These values are roughly equivalent to 10 mSv/a in terms of latest ICRP thinking

THE NEW BSS (cont.)

Only few exposures to natural sources, by exception, are subject to the requirements for planned exposure situations.

One of these particular cases is the exposure to material (other than commodities such as food, driking water, fertilizers and construction material) with a radionulide concentration exceeding 1 Bq/g for the U and Th decay series, or 10 Bq/g in the case of of ^{40}K (exposure to NORM).

In the new BSS, for the first time, numerical criteria for exemption and clearance of NORM have been included.

The exemption is determined on the basis of dose commensurate with the natural background (about 1 mSv /year) and the clearance criteria for NORM 1Bq/g for U and Th series radionuclides and 10 Bq/g for ^{40}K.

Planned exposures: Gradded approach to regulation

One of the key principles of BSS

The application of the requirements for planned exposure situations **"shall be conmensurate with the characteristics of the practice or source and with the magnitude and likelihood of exposures".**

This key principle is particularly relevant for NORM industries because the exposures are generally moderate with litlle or no likelihood of extreme radiological consequences due to acidents.

Gradded approach to regulation

1.- EXEMPTION

If dose from gamma and dust is less than about 1 mSv/a, after taken existing industrial hygiene controls into account

2.- NOTIFICATION

If dose from gamma and dust is << dose limit, after taken existing industrial hygiene controls into account (similar to exemption but the regulator remains informed)

3.- NOTIFICATION + REGISTRATION

Minimal additional controls for gamma and dust needed, after taking existing industrial hygiene controls into account

4.- NOTIFICATION + LICENSING

Specific measure to control actions of workers – needed only when dealing with very high activity material in significant quantities.

Regulatory control of NORM in planned exposure situation

Exemption

Responsible authority should establish exemption criteria based on dose

- **Taking into account economical, social and political factors**
- **Balancing the consequences of regulatory control, in terms of impact on the NORM activity, against the benefit in terms of approved radiation protection**

Exemption criteria

- **Dose : 1 mSv/a for workers**

Will restrict doses to the public to lower values

BSS on radon

Special criteria for radon in workplaces

Exposure to radon is not normally regulated as a practice, as it is subject to the requirements for existing exposure situations: A reference level is set , above which it is not appropriate to plan to allow exposures to occur — maximum 1000 Bq/m^3

However, **Occupational exposure to radon is subject to regulation according to the applicable requirements for planned exposure situations if:**

- **Exposure to other U, Th series radionuclides is already controlled as a planned exposure situation, e.g. underground mining of radioactive ores**

or

- **After remedial action, the radon concentration remains above the reference level, e.g. underground mining of non-radioactive ores**

THE NEW BSS (cont.)

It seems evident that the revised BSS would provide greater clarity on the control of exposure to natural sources although its application will be far to be trivial, being unavoidable the remaining of several challenges for their proper implementation in the NORM industry.

The new BSS has simplified its structure and in its revision has been improved the treatment of exposure to natural sources in international standards. This improvement has been mainly performed through the greater use of quantitative criteria rather than qualitative criteria.


Challenges

Challenges (I)

Some efforts should be needed for the proper implementation and full understanding by the affected community of the newly introduced "reference level" concept.

The tendency observed in the first months of implementation of the new BSS to simply interexchange the concepts of action levels and reference levels should be properly corrected.

The "reference levels" sometimes have been used as limits defeating the purpose of optimization.

These efforts should be accompanied for the continuous didactic dissemination of the basic concepts of exclusion, exemption and clearance that historically have been applied confusingly/wrongly by a no negligible fraction of the actors involved in the radioprotection of NORM material.

Reference Levels vs. Action levels (I)

The change from “action levels” to “reference levels” is far from being anecdotic.

In addition to an evident change in the philosophy of regulation, the selection of numerical values for the “reference values” quite identical to the previously established in the old BSS for the “action levels” resulted in a very significative increase in the stringency of protection measures in existing exposures situations.

This increase is principally through the removal of what was effectively a lower bound on the application of the optimization process.

Reference Levels vs. Action levels (II)

The increase in the stringency, in the case of radon is based in the fact that the ICRP (basis of the BSS) now considers the dose per unit activity concentration of inhaled radon to be significantly higher than previously assumed.

The practical coincidence in numerical values between the reference levels indicated in the new BSS and the action levels associated to the old BSS has provoked the previously commented and no desired tendency to dismissed simply the change of action levels to reference levels as a change in terminology, that needs to be avoided.

Planned vs. Existing exposures

The concepts of planned and existing exposure situations not fully understood in terms of practical information.

When some doubts appear about which type of requirements (planned or existing exposure situations) should be implemented, by default these cases should be treated as existing exposure.

It is then followed the philosophy of the BSS that treat the great majority of exposures to natural sources as existing exposure situations.

The selection performed in these unclear cases is only based in taking practicability as the most important consideration, because the exposure should be controlled regardeless of the type of situation.

Individual Industrial Approaches

BSS developed for the NORM industry in general. but…

Individual NORM industries are very different as are the practical radiation protection challenges they face.

No single approach is appropriate for all industrial NORM processes

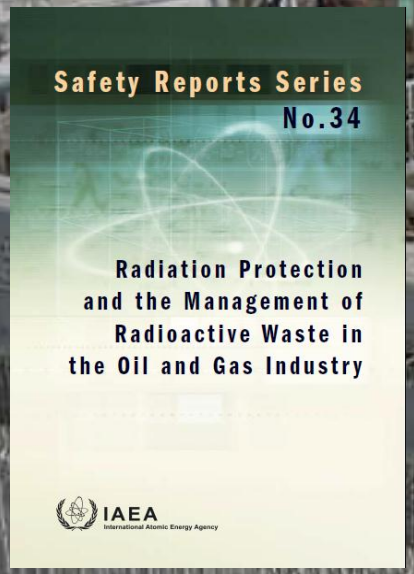
In NORM industries, most of the actions taken to comply with regulation are situation specific and very hard to generalise. The idea of a common protocol to control the exposures in all the NORM industries should be forgotten

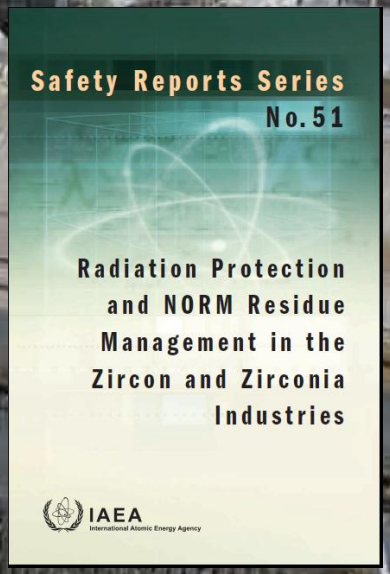
The " positive list" of industrial sectors

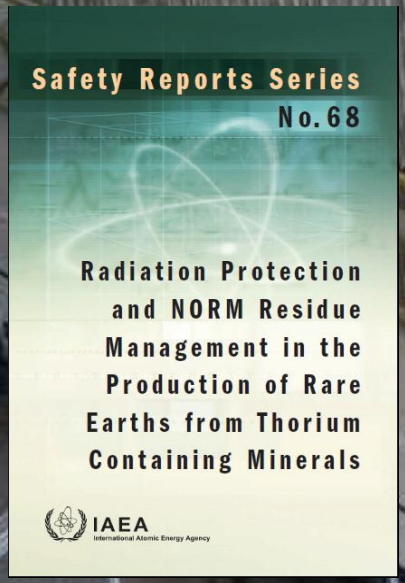
The “positive list”

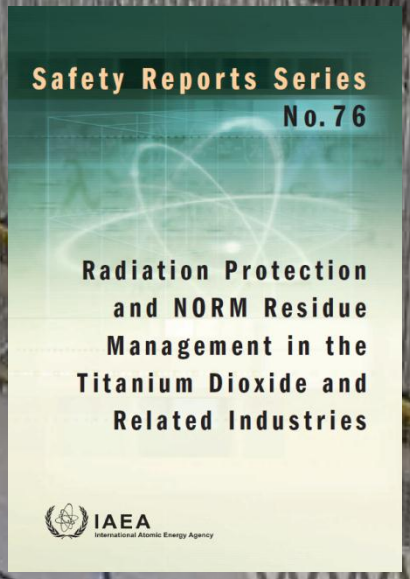
Industrial sectors most likely to require some form of regulatory consideration
Uranium mining and processing
Rare earths extraction
Thorium extraction and use
Niobium extraction
Non-U mining- including radon
Oil and gas
Production and use of TiO2
Phosphate industry
Zircon and zirconia
Metals production (Sn, Cu, Al, Fe, Zn, Pb)
Burning of coal
Water treatment-including radon

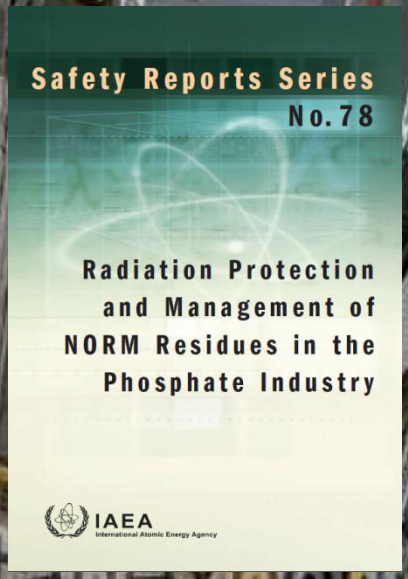
Individual Industrial Safety Reports









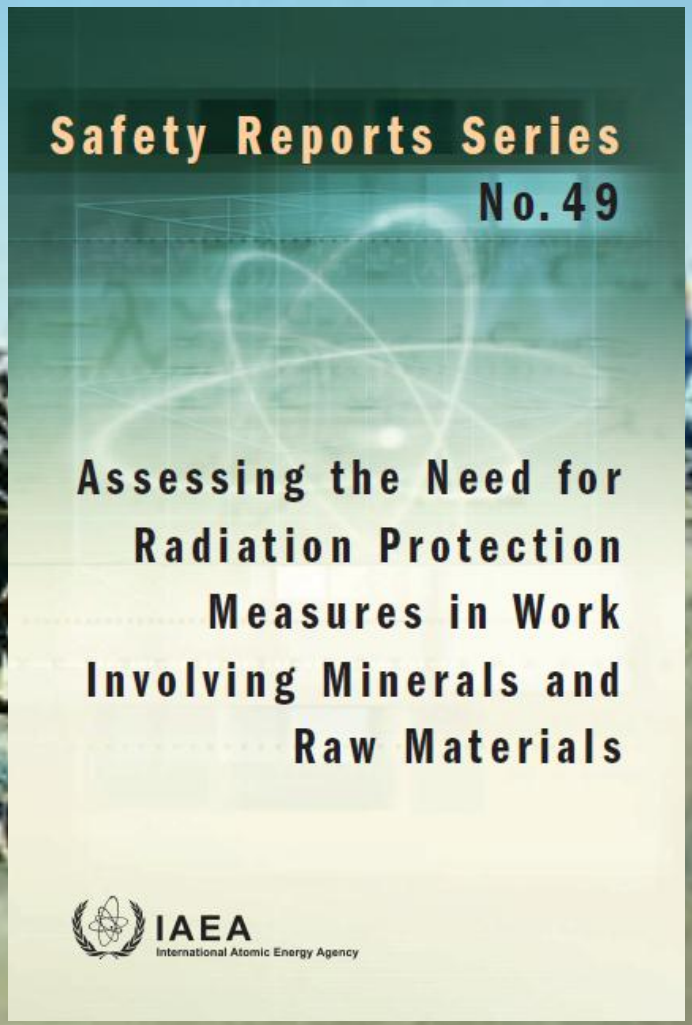


Assessing the need…..

Excellent Safety Report from where the dimension and magnitude of the radiation Protection in the NORM industry is clearly deduced.

The most important key points concerning RP in the NORM industry are didactically introduced and explained.

Is “imperative” the survival of this safety report in all it dimension. For that reason , some parts need to be adapted to the new BSS.



Approaches to decrease occupational doses….

Through the individual studies performed in NORM industries, it is clear that in most of the workplaces of NORM industries the worker doses are lower than 1 mSv/year.

They are few exceptions related with U/Th mining and processing, rare earths extraction etc, where there is a potential for higher exposures if adequate control measures are not implemented.

The majority of published studies have been concentrated in determining individual doses in order to establish the need or not of regulatory control, but only in extremely limited number of the needed cases information is given on how such doses might then be optimized in practice.

Additional studies in NORM workplaces where dose optimization are needed should be performed, with special emphasis in the evaluation of alternative approaches to decrease occupational doses in practice.

Assessment of worker doses….

The methodologies for realistic assessment of worker doses suffer from non-standardised approaches, being necessary to plan how this standardisation can be approached.

The emphasis should be put on actual monitoring data (individual and workplace) to ensure that the dose estimates are realistic, rejecting the approaches based in conservative models.

In particular, it is important the standardisation in the determination of occupational inhalation doses which suffers until now of a tendency for the application of simplified non-validated approaches.

Lack of Measurement Infraestructure….

A lack in the development of standardisation is found also in the NORM industries associated to the measurements methods and protocols to determine the radionuclide concentrations in their raw materials, products and residues.

There is a clear industrial lack of sufficient infrastructure to analyse and interpret radionuclide concentrations.

There is an associated lack of qualified experts for radiation protection in the NORM industries.

There is a lack in the development and standardization of field methods for activity analysis in industrial samples.

These lacks are partially covered by some radiation protection service companies…. But only partially.

Third-Party Service companies….

A particular case that needs special attention is the corresponding to some service companies specialized in the performance of maintenance and cleaning activities for some NORM industries.

The workers of these companies do not have a defined workplace (it changes along the time) and can be subject to no trivial doses, because its labour is in relation with the removal of wastes like scales, filter clothes, etc, heavily enhanced normally in gamma-emitters natural radionuclides.

A strict dosimetric control of these workers should be performed, in order to control them by the appropriate regulatory body, taking in consideration that the changes in the workplaces can even produces the overpassing of national borders, with all the implications associated.

Remediation from past activities (I)

Many NORM related industrial sites were abandoned in the past with little or no remediation and inefficient residue management. Attending to the BSS, requirements for existing exposure scenarios shall be applied, being a challenge the establishment of coordinated international efforts for remediation with a proper implementation of the reference level concept.

The goal of the remedial actions shall be the timely and progressive reduction of the hazard and eventually, if possible, the removal without restrictions of regulatory control from the area.

In cases where the removal of control cannot practicably be achieved, at least the unacceptable risks to human health and the environment shall be removed and any restrictions on access to or use of the area and any other restrictions shall be established on the basis of an optimization process.

Remediation from past activities (II)

The remediation shall be justified by means of a decision aiding process requiring a positive balance of all relevant attributes relating to the contamination.

The remediation shall be optimized following the general approach to the optimization of protection. The optimum nature, scale and duration of the remedial actions shall be selected from a set of justified options for remediation.

In some cases, the need for protective action in the form of restricted use of human habitats may be the outcome of the optimization process for remediation

Remediation from past activities (III)

In addition, the design and application of the remedial actions in order to cover the objectives pursued, shall be complemented with the detailed exposure control of the workers involved in their implementation.

A strict assessment of the different routes of occupational exposure shall be performed in each individual case, and if needed, radiological controls shall be adopted or even specific measures to control actions of workers shall be applied.

Management of NORM residues

The need for minimising radioactive waste is one of the basic principles embodied in the IAEA safety standards

Increasing acceptance on the concept of use of NORM residues rather than disposal.

- **Many instances of residue recycling and use**
- **Instances of dilution**

Management approach needs to be tailored to the particular industrial activity and its location

A risk-based and situation specific approach is essential

Management of NORM residues (II)

For some NORM industries, especially those producing low or medium volume residues with higher activity concentrations, a suitable waste disposal repository is the only solution, being in the last years increasingly accepted that these NORM residues may disposed in a manner similar to that for other hazardous wastes.

For residues of moderate content of radionuclides there is an increasing acceptance on the concept of use rather than the disposal, being the recycling an emerging option. In case of waste disposal, exposure control of the workers involved in its management and maintenance should be assured.

Valorization….. with scientific evidences

Cement & Concrete Composites 37 (2013) 76–81

Contents lists available at SciVerse ScienceDirect

Cement & Concrete Composites

journal homepage: www.elsevier.com/locate/cemconco

Evaluation of the use of TiO_2 industry red gypsum waste in cement production

M.J. Gazquez [a], J.P. Bolivar [a], F. Vaca [a], R. García-Tenorio [b,*], A. Caparros [a]

[a] Department of Applied Physics, University of Huelva, Spain
[b] Department of Applied Physics II, University of Sevilla, Spain

Journal of Hazardous Materials 191 (2011) 269–276

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Physico-chemical and radioactive characterization of TiO_2 undissolved mud for its valorization

M.J. Gázquez [a], J. Mantero [b], J.P. Bolívar [a,*], R. García-Tenorio [b], F. Vaca [a], R.L. Lozano [a]

[a] Department of Applied Physics, University of Huelva, Huelva, Spain
[b] Department of Applied Physics II, University of Seville, Seville, Spain

SCIENCE OF THE TOTAL ENVIRONMENT 403 (2008) 80–88

available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/scitotenv

Science of the Total Environment

The cumulative effect of three decades of phosphogypsum amendments in reclaimed marsh soils from SW Spain: ^{226}Ra, ^{238}U and Cd contents in soils and tomato fruit

José-María Abril[a,], Rafael García-Tenorio[b], Santiago M. Enamorado[a], M. Dolores Hurtado[c], Luis Andreu[c], Antonio Delgado[c]*

[a] Dpto. Física Aplicada I, Universidad de Sevilla, EUITA, Ctra Utrera Km 1, 41013 Seville, Spain
[b] Dpto. Física Aplicada II, Universidad de Sevilla, ETSA, Avda. Reina Mercedes s/n, 41012 Seville, Spain
[c] Dpto. Ciencias Agroforestales, Universidad de Sevilla, EUITA, Ctra Utrera Km 1, 41013, Seville, Spain