IAEA GSR Part 3
Public exposure – reference level 1 mSv/year

NORM in building materials
Accredited methods and experience working with testing of NORM in building materials

TONY LÖFQVIST
TECHNICAL MANAGER
MARK- OCH MILJÖKONTROLL AB (MMK)
SWEDEN

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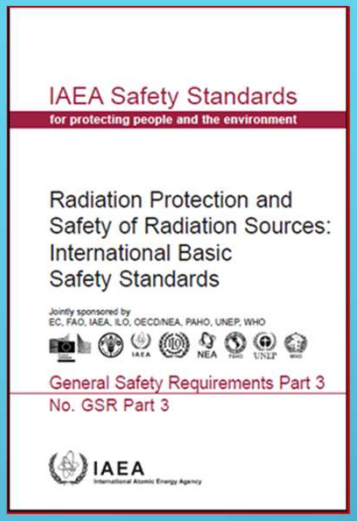
IAEA SAFETY STANDARDS



Requirement 51

Exposure due to radionuclides in commodities

The regulatory body or other relevant authority shall establish reference levels for radionuclides in commodities.

- The regulatory body shall establish specific reference levels for exposure to radionuclides in construction materials, food, feed and drinking water, and the reference level is not to exceed 1 mSv.

Note! The radionuclides are not specified in this requirement (could be NORM and/or any other artificial nuclides).

DIRECTIVE 2013/59/EURATOM

Laws and regulations for construction materials

EU COUNCIL DIRECTIVE 2013/59/EURATOM

of 5 December 2013

laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation

Article 75

Gamma radiation from building materials

1. The reference level applying to indoor external exposure to gamma radiation emitted by building materials, in addition to outdoor external exposure, shall be 1 mSv per year.

2. For building materials which are identified by the Member State as being of concern from a radiation protection point of view, taking into account the indicative list of materials set out in Annex XIII with regard to their emitted gamma radiation, Member States shall ensure that, before such materials are placed on the market:

(a) the activity concentrations of the radionuclides specified in Annex VIII are determined, and that,

(b) information to the competent authority on the results of measurements and the corresponding activity concentration index, as well as other relevant factors, as defined in Annex VIII, are provided if requested.

DIRECTIVE 2013/59/EURATOM

- Construction material ≤ 1 mSv/a
- Activity Index (AI) = 1 ensures compliance with 1 mSv per year
- AI = (K * 313/3000) + (U * 12,35/300) + (Th * 4,06/200)

How shall the construction industry and the regulatory authorities solve the task of standardisation and testing of aggregate construction materials including the end product concrete?

AMOUNT OF CONSTRUCTION MATERIALS & TESTS WE ARE TALKING ABOUT

Annual aggregate and concrete production in the EU (2015)

- Aggregate production:

- EU	2 510 000 000 ton
- Sweden	90 000 000 ton

- Concrete production:

- EU	approx:	300 000 000 m³	(705 000 000 ton)
- Sweden		5 800 000 m³	(13 630 000 ton)
- Worldwide (2012)			(3 700 000 000 ton)

- Volume of use (in percentage) for the annual concrete production in Sweden:

- Housing	78,5 %
- Infra structures	21,5 %

WHAT IS NEEDED

- To fulfil the regulated level of 1 mSv/year from construction materials
- Testing of NORM nuclides in the beginning of the material cycle
- Accredited test methods (in accordance with ISO/IEC 17025)
- Laboratory capacity (in compliance with regulation (EC) No 765/2008)
- Certified, factory control system (functional in the production) for in situ testing
- Standards for test cycles (preferably already existing, approved and applied by the industry)
- High test capacity
- Quick reliable results
- Low investment costs
- Low price per test
- Minimum time loss (which is crucial for the industry with its enormous output of construction materials to the market and public)

Is this possible?

YES IT IS – BUT HOW?

- Step 1:

MMK A2 610 for in situ testing already in the rock pit.

- Step 2:

MMK A2 605 for production control in the concrete factories.

- Step 3:

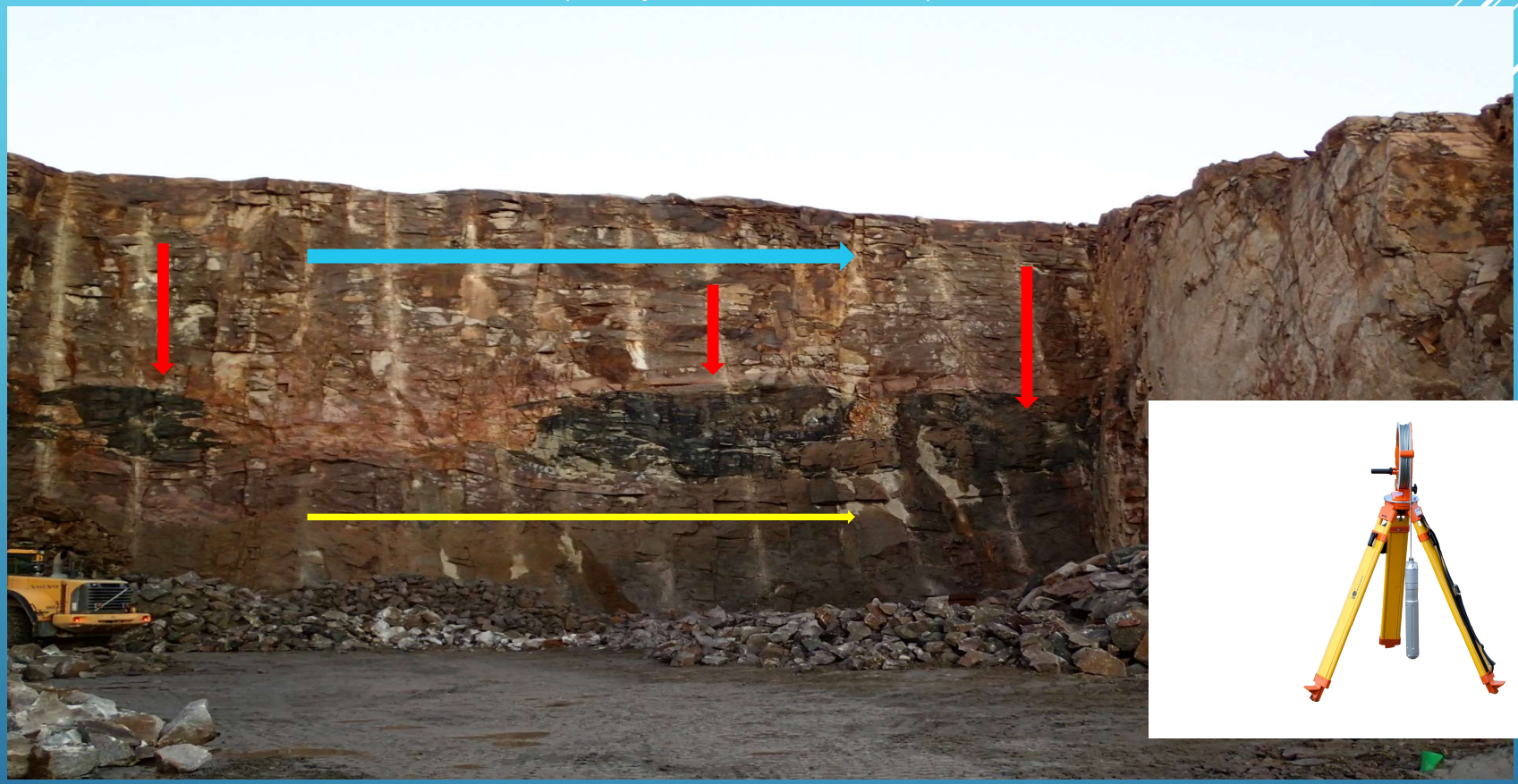
MMK 608 for dose rate testing inside constructed buildings.

- Step 4:

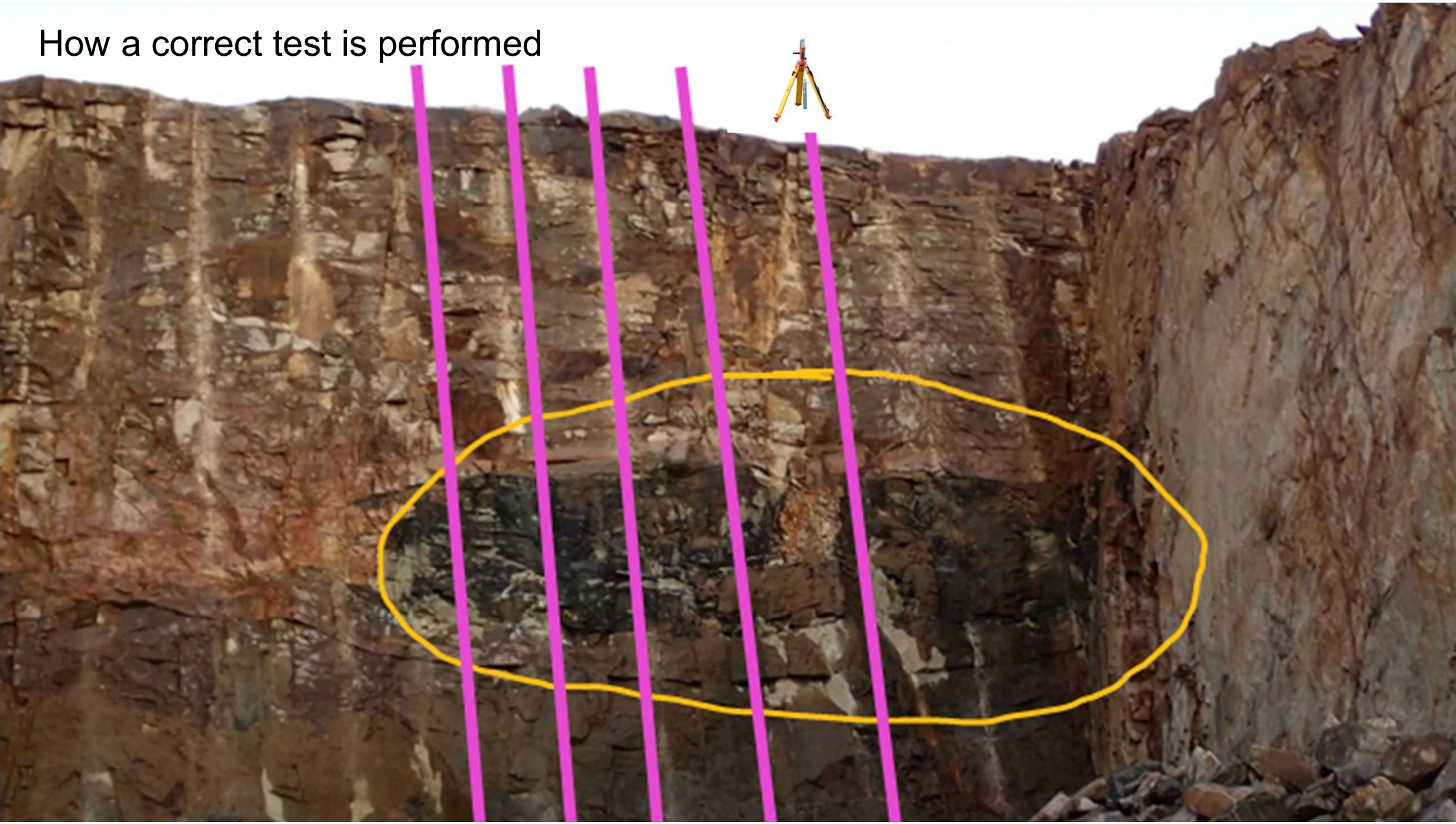
MMK A2 606 for determination of exactly which part of the construction in the room/building is the main source of high dose rate (floor, wall and/or roof construction).

Method MMK A2 610 - Aggregate material

The example below is from a Swedish quarry. Note that there are 3 different kinds of rock material (blue, yellow and red arrows).



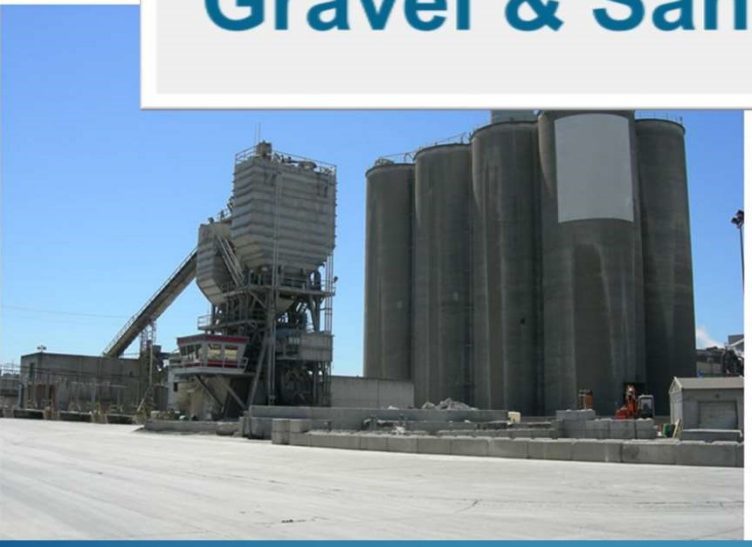
How a correct test is performed



From rock to stone based construction material

Standard EN 206

Gravel & Sand + cement & water = Concrete



METHOD MMK 605 – FACTORY CONTROL

Public exposure – 1 mSv/year = Activity index 1

Method MMK A2 605 - Accredited by Swedac

- Applied for standardisation at SIS and

suggested as compliance method for the EU

- Test sample size in regulation with concrete **standard EN 206**

Test size = 150 mm * 150 mm * 150 mm

Test weight ≈ 5 000 - 8 000 gram (in intended form of use)

Testing time = 2 x 5 minutes = 10 minutes

- Detection limit at 300 seconds

K ≥ 0,4 % – U ≥ 1,5 ppm – Th ≥ 3,25 ppm = 0,17 in activity index

Examples for test interval:

EN 206:13 Concrete 1/400m³

EN 13242 Unbound fractions 1/week or 2/2000 ton

EN 12620 Concrete components 1/week or 1/2000 ton

EN 13043 Asphalt material 1/week or 1/2000 ton

AN EXAMPLE: METHOD MMK 605

Method MMK A2 605 - for measurement and estimation of NORM content in stone-based construction materials

- Accredited by the Swedish accreditation authority SWEDAC (valid throughout EU).
- Calibration standard with traceability to IAEA NORM standard.
- The test specimen choice is in accordance with existing industrial standard EN 206.
- Measurements of construction material in its intended form of use.
- Simplified routine due to minimum manual handling of material and equipment.
- Significantly improved confidentiality of results due to large test specimen ≈ 8 000 gram.
- Significantly better daily measurement capacity – 10 minutes/test.
- Low laboratory investment and running costs.
- Gives compliance possibilities with the Directive on consumer product liability for defective products (85/374/EEC).
- The method and the instrument are suitable for daily factory control purposes.

Control of public exposure, 1 mSv/year, in existing room/building

Method MMK 608 - for measurement of dose in existing room/building

- In process for accreditation at the Swedish accreditation authority SWEDAC (valid throughout EU).
- Measurements of building material in existing room/building.
- High daily measurement capacity – 10 minutes/test.
- If the result is lower than 1 mSv/year no further action is needed.
- If the result is higher than 1 mSv a radon measurement is performed at the same time with an approved integrated radon instrument or with a 7 days radon track device that will manage the radon dose deduction from the measured dose.
- If the result is still over 1 mSv/year in the room, a much more advanced and time consuming method has to be used: Method MMK 606, which is used for determining exactly which construction material is causing the problem: wall, floor and/or roof construction.
- The method gives compliance possibilities with the Directive on consumer product liability for defective products (85/374/EEC).

SOLUTIONS

There are only very expensive solutions available if the dose is over 1 mSv/year!

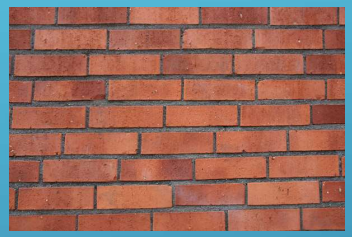
The radiation source has to be covered (shielded) with high density materials such as lead, clay or concrete bricks, or ceminwood which is a wood/concrete material. The thickness that is needed for the different subduing (shielding) materials depends on the radiation level and the density of the material that is used.

In reality, due to handling and costs, ceminwood or clay/concrete bricks has to be used in one or several layers.

Densities:

- 1 cm lead = 113,6 kg/m.
- 10 cm clay bricks = 140 – 180 kg/m.
- 10 cm concrete bricks = 235 kg/m.
- 10 cm Ceminwood = 137 kg/m.

Building boards 1200 x 2400 mm + 1200 x 3200 mm



METHODS:
MMK 605, MMK 606, MMK 608 & MMK 610

The methods for measurement of NORM radionuclides (K-40, Ra-226 (Uran 238/235) and Th-232) and estimation of radium index, activity index and gamma dose rate in different stone-based construction materials is developed with the objective to fulfil a number of requirements set out in international directives, regulations and standards.

- IAEA Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, No. GSR Part 3
- EU Directive 2013/59/Euratom, repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom
- Regulation (EU) No 305/2011 on harmonised conditions for the marketing of construction products
- Regulation (EC) No 765/2008 of the European Parliament and of the council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products
- Radiological Protection Principles concerning the Natural Radioactivity of Building Materials, EC RP 112 (1999), 1999

CONCLUSIONS

- Testing of raw material before production and concrete/aggregate cubes during production are the most efficient ways of controlling public exposure from building materials.
- Methods for mitigation of buildings with high gamma dose-rate are very expensive and complex.
- If measurements of building materials are quick, reliable and cheap it will facilitate the implementation and enforcement of IAEA Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, No. GSR Part 3 and the Directive 2013/59/Euratom for the best interest of the public and industry.
- All parties involved will be willing and able to comply with what is needed from now on; and, the public exposure will be controlled in an effective manner so that the demand of 1 mSv/year can be fulfilled.

THANK YOU FOR YOUR TIME AND INTEREST

Mark- och Miljökontroll i Särö AB (MMK)

Accredited Laboratory nr. 2052 Swedac

Tony Löfqvist Technical Manager

www.markomiljo.se

Tony Löfqvist is a consultant for the ***International Atomic Energy Agency (IAEA)***.

Tony Löfqvist is an expert member of the ***Swedish Standards Institute (SIS)*** and Sweden's expert in the EU TC 351, WG 3 and TG 31 and TG 32.

MMK is a referral organisation for the:

- ***Swedish Radiation Safety Authority (SSM)*** and
- ***National Board of Housing, Building and Planning (BV)***