TRANSPORT OF LARGE COMPONENTS IN GERMANY SOME EXPERIENCES AND REGULATORY ASPECTS

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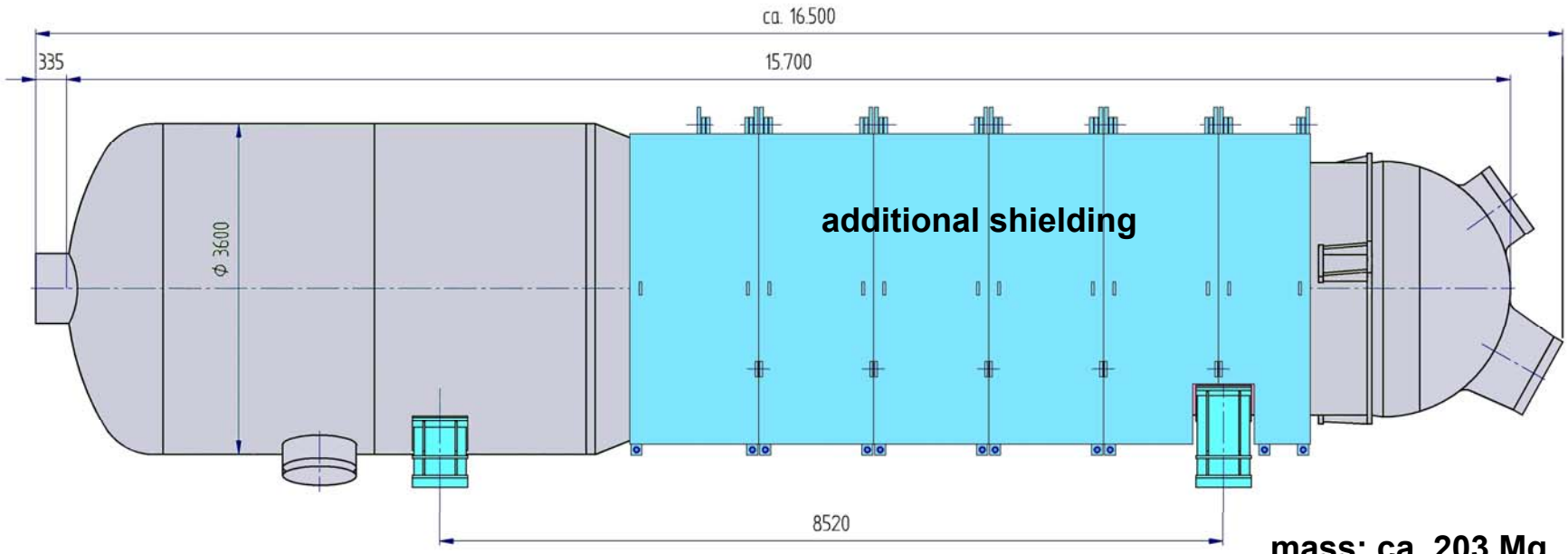
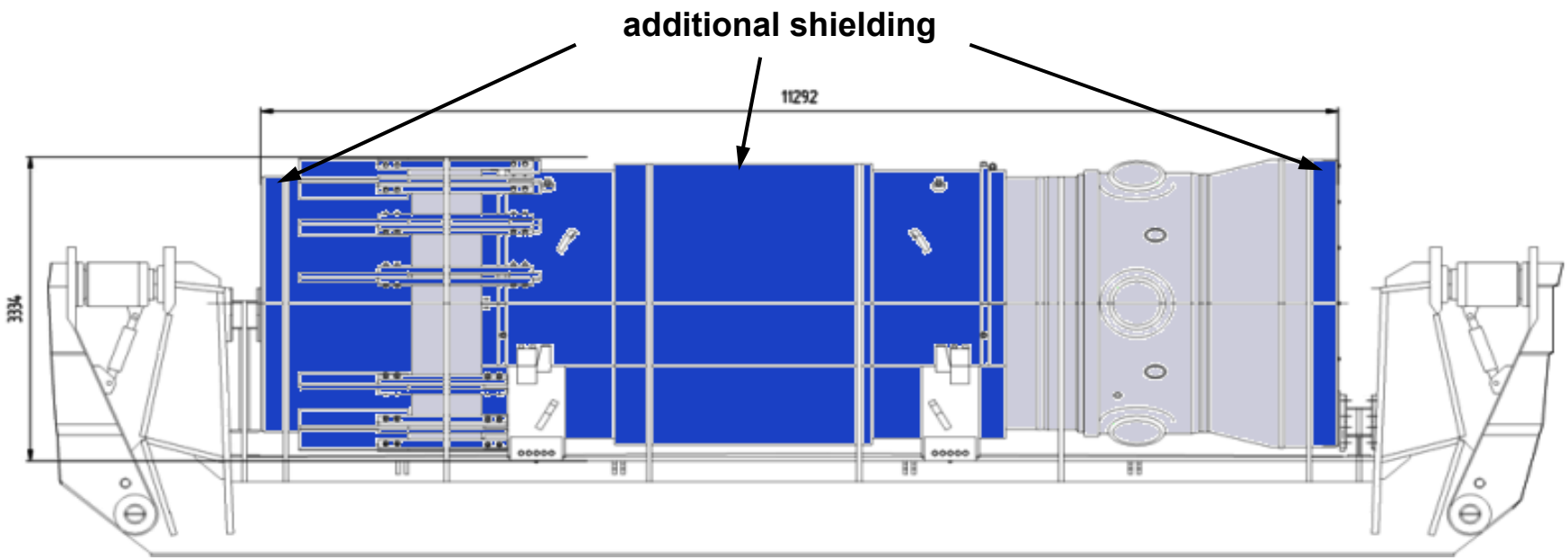
Large component (1)
Steam generator in transport position



mass: ca. 203 Mg

Large component (2)
Reactor pressure vessel in transport position



mass: ca. 170 Mg

Demonstration of full compliance with one of the usuel package types not possible

→ Shipment under special arrangement

Transport Stade - Studsvik (1)

- 4 steam generators
- from 19 – 23 September 2007
- by road and sea

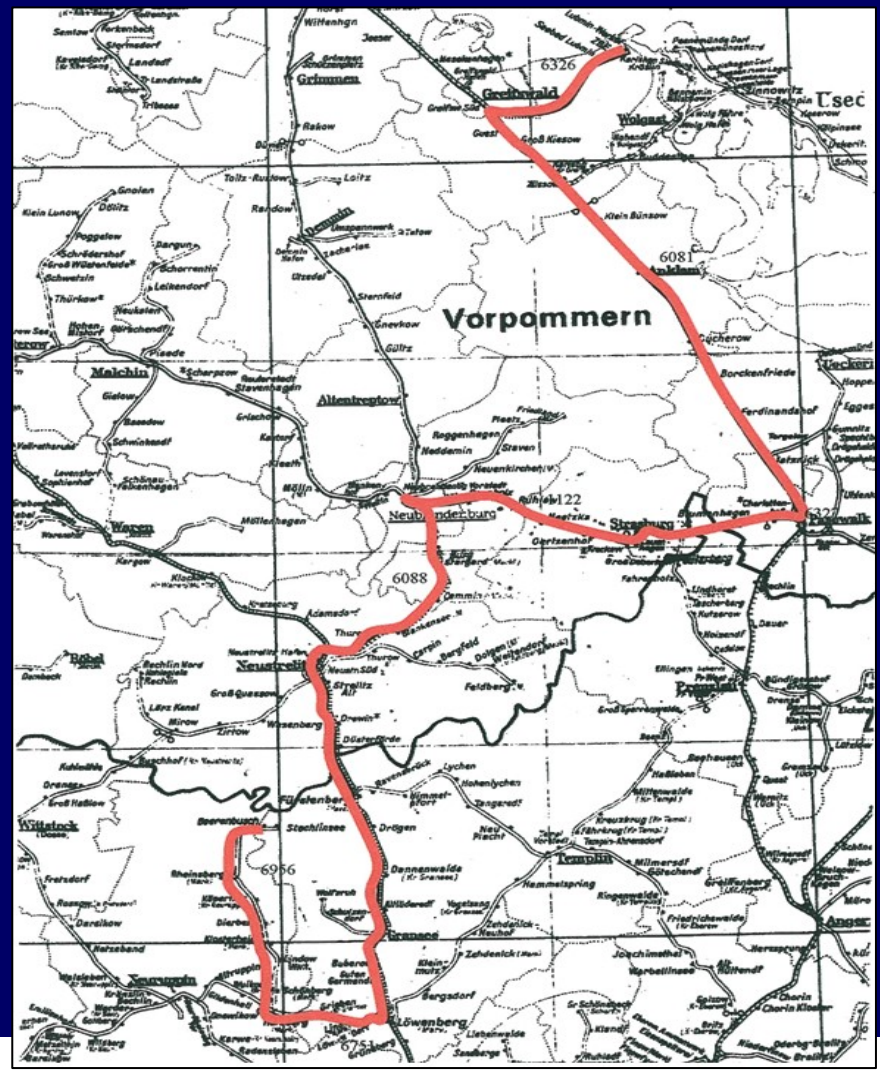
Transport route from NPP Stade to Studsvik (Sweden)

Transport Stade - Studsvik (2)

Transport Stade - Studsvik (3)

Transport Rheinsberg - Lubmin (1)

- 1 reactor pressure vessel
- from 30 - 31 October 2007
- by rail (about 300 km)



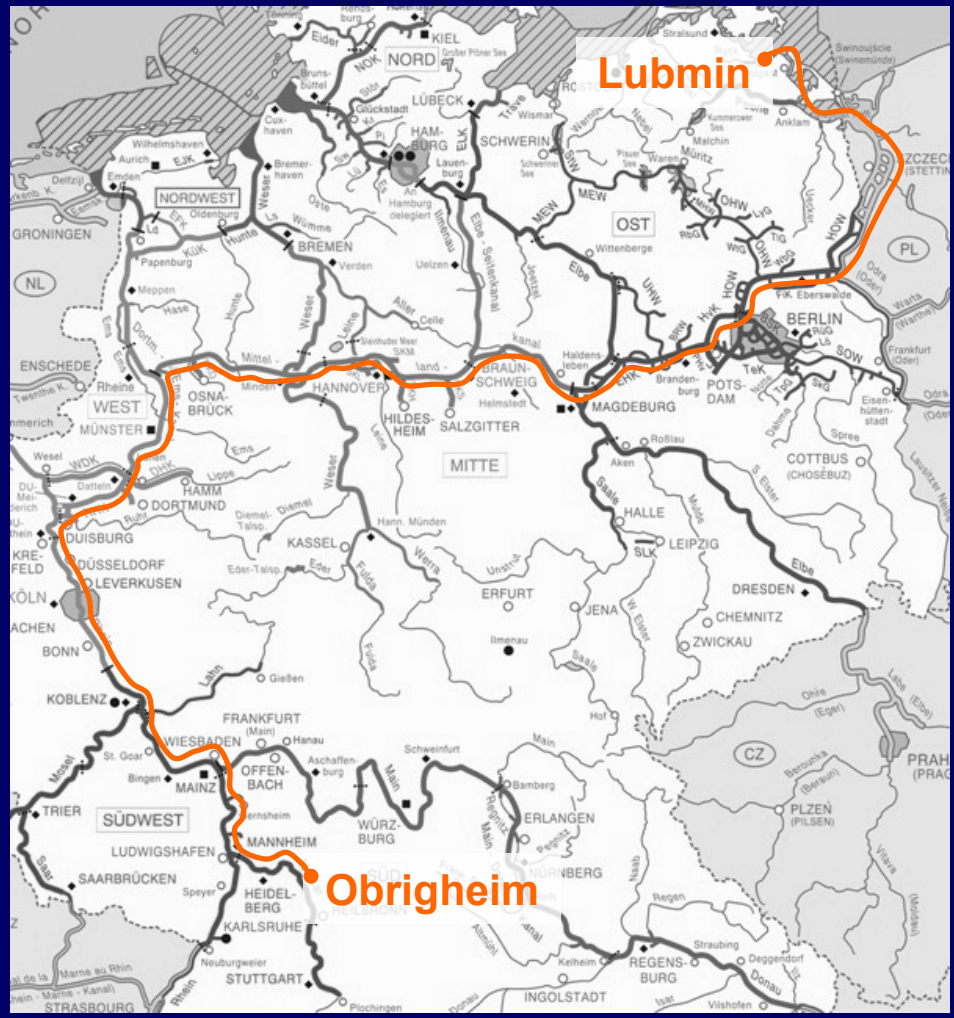
Transport route from NPP Rheinsberg to storage facility Lubmin

Transport Rheinsberg - Lubmin (2)

Transport Rheinsberg - Lubmin (3)

Transport Obrigheim - Lubmin (1)

- 2 steam generators
- 23 September - 8 October 2008
- by road and inland waterway (temporarily on the territory of Poland)
- About 1400 km inland waterway



transport route from NPP Obrigheim to Lubmin

Transport Obrigheim - Lubmin (2)

Transport Obrigheim - Lubmin (3)

Experiences

- The implementation of the special arrangement conditions as specified in the BfS approval certificate provided a high level of safety for all modes of transport

- The application of appropriate mode specific radiation protection programmes ensured low radiation doses to involved persons during transport

  0.058 mSv for stowage personnal on the seagoing vessel

  0.080 mSv for personnal on road vehicle (loading, securing)

  below detection limit for personnal on the inland waterway craft

- Special arrangement procedure provided good results in practice

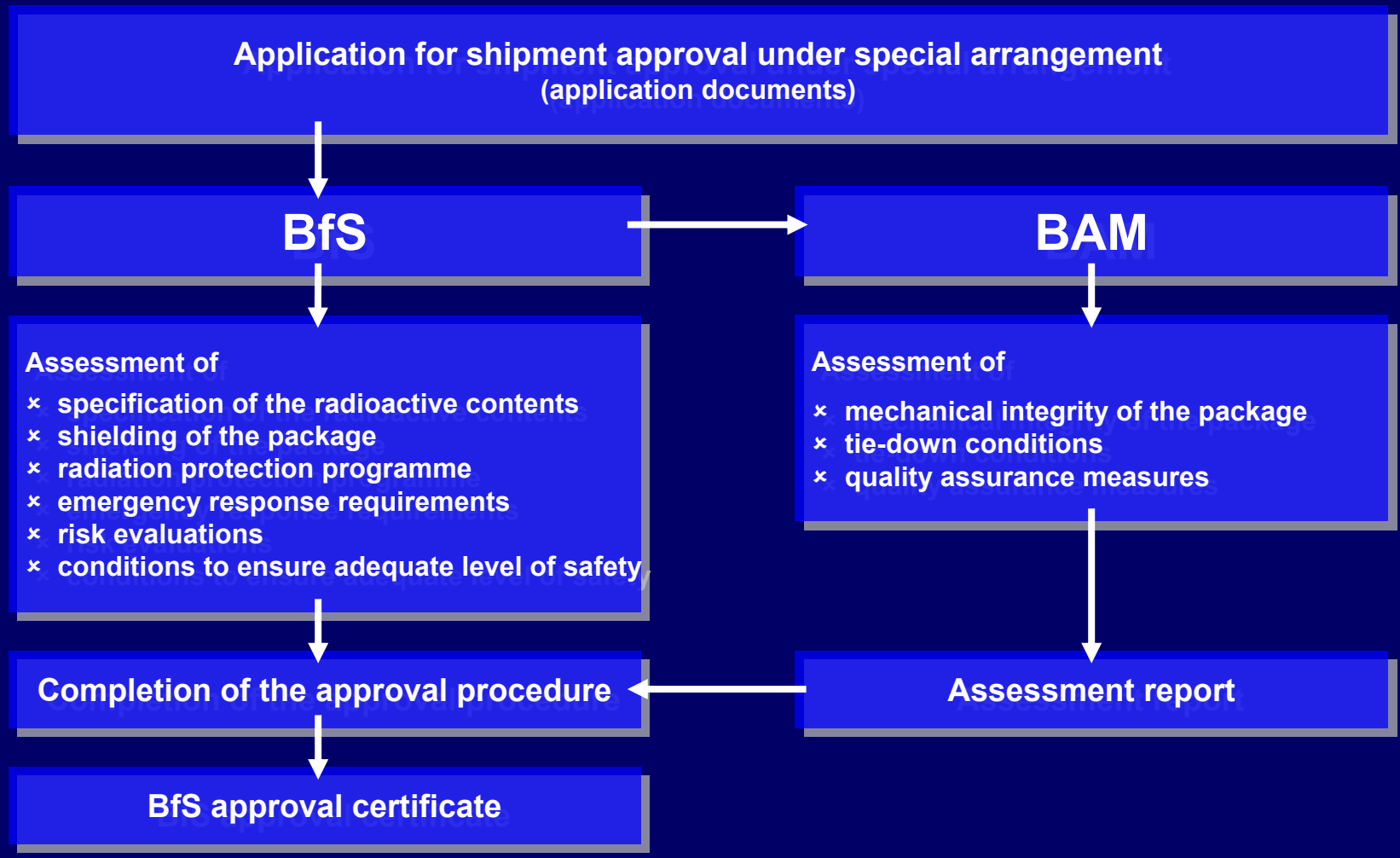
Essential requirements for special arrangement

- those provisions, approved by the competent authority, under which consignments of radioactive material which do not satisfy all the applicable requirements of the Regulations may be transported
- conformity with all provisions of the Regulations is impracticable …. …… standards of safety established by the Regulations have been demonstrated through alternative means
- the overall level of safety in transport shall be at least equivalent to that which would be provided if all the applicable requirements had been met
- an application for approval of shipment under special arrangement shall include all the information necessary to satisfy the competent authority

Information to be provided by the applicant

- Validity period of the special arrangement approval
- Modes of transport, types of conveyances, transport route
- Specification of the actual radioactive contents
- Description of the packaging and the dose rate field around the package
- Reason why the shipment cannot be made in full compliance with the applicable requirements
- Technical and administrative measures to ensure that the overall level of safety in transport is at least equivalent to that which would be provided if all applicable requirements had been met in conjunction with appropriate risk considerations
- Statement of any special precautions or special administrative / operational controls during carriage to compensate for the failure to meet the applicable requirements
- Radiation Protection Programme (RPP) which must take into account all steps and activities of transport and all relevant workers and members of the public
- Emergency response procedures

Special arrangement approval procedure



Main criteria to demonstrate equivalent level of safety

Steam generator: mainly contaminated material → SCO-II, IP-2
Reactor pressure vessel: contaminated and activated material → SCO-II + LSA, IP-2

Applicable requirements	Steam generator	Reactor pressure vessel
• SCO-II contamination limits	X	X
• LSA-II / III specific activity limits		X
• IP-2 package requirements, mainly maintaining package integrity under 0.3 m drop test conditions without - loss or dispersal of radioactive contents, and - more than 20% increase of maximum surface radiation level	X	X
• 10 mSv/h dose rate limit at 3 m distance from the unshielded radioactive contents	X	X
• Conveyance activity limits for SCO - 10 A_2 for inland watercraft - 100 A_2 for all other conveyances	X	X

Assessment of applicable requirements and derivation of compensatory measures

Steam generator:

a) Compliance with SCO-II contamination limits for the inner heat exchanger tubes could not be proven free of doubt
b) IP-2 package integrity level could not be demonstrated for certain drop positions

Reactor pressure vessel:

same as b) above

Technical compensatory measures:

- Specific fixation, tie-down and handling conditions to ensure that such drop positions could not occur during transport
- Use of additional shielding as part of the package to comply with dose rate thresholds and to decrease individual doses to persons

Additional administrative/operational conditions:

- notification of the involved authorities before and during the shipment,
- limitation of the velocity of the vehicle (rail and road transport),
- restrictions on the ambient temperature conditions (for reactor pressure vessel),
- emergency response requirements, and
- operational controls for preparation, loading, shipment and unloading

Future developments

- Transports of large components will increase in the future
- Development of internationally harmonized regulatory approach desirable
- First actions within current IAEA revision process of TS-R-1 and TS-G-1.1: Draft TS-G-1.1 (DS 425) contains new Appendix VII “Guidance for transport of large components under special arrangements” (for comments until 2010-12-06)
- Safety concept of this guidance material is consistent with the described approach of this presentation
- Based on own experience additional generic guidance regarding the permissible total radioactive contents of a steam generator under accident conditions of transport can be provided

Contents limit of a steam generator under accident conditions of transport

Basis: Dose to a person exposed in the vicinity of the steam generator following a severe accident should not exceed 50 mSv (Intake < 10^{-6} A_2)

a) Exposure due to gamma radiation:

Dose rate limit of 10 mSv/h at 3 m distance from the unshielded radioactive contents Q_{tot}
SAS4-Code radiation field calculation for typical heat exchanger tube bundle for Co-60

→ Q_{tot} = 2.8 TBq = 7 A_2

b) Exposure due to inhalation:

steam generator damaged by mechanical impact equivalent to the 9 m Type B drop test

total acticity contents Q_{tot} ≈ 10 A_2 … 100 A_2

released activity $Q_{rel} \approx 10^{-2} \ldots 10^{-3} Q_{tot}$ (Q-System)

inhaled activity $Q_{inh} \approx 10^{-5} Q_{rel}$ (F. Lange) 10^{-6} A_2

If both exposure routes are considered it can be concluded that for $Q_{tot} \approx 5$ A_2 … 10 A_2 an adequate level of safety is ensured also under accident conditions of transport

Conclusions

Within the framework of decommissioning nuclear power plants transports of large components are necessary.

Experiences with shipments of steam generators and a reactor pressure vessel in Germany have shown that the procedure of special arrangement approval could be applied very successfully and that by implementing appropriate conditions an adequate level of safety during transport could be achieved in compliance with the transport regulations.

Experiences should also be used to develop a more specific and internationally harmonized regulatory approach for these type of shipments. First results have been achieved within the current IAEA revision process of TS-R-1 and TS.G-1.1 by developing new advisory material for transport of large components under special arrangement.

Experiences in Germany support the proposed advisory material and can be used to derive additional guidance as presented. All interested parties should use their experiences to provide their input to this IAEA revision process within due time (6th December 2010 for TS-G-1.1)