

**IAEA ANSN / ISSC - REGIONAL WORKSHOP ON
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**Population Considerations and
Demonstration of the Feasibility of an
Emergency Plan**

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Lecture 19

Population Aspects

Motivation for population considerations

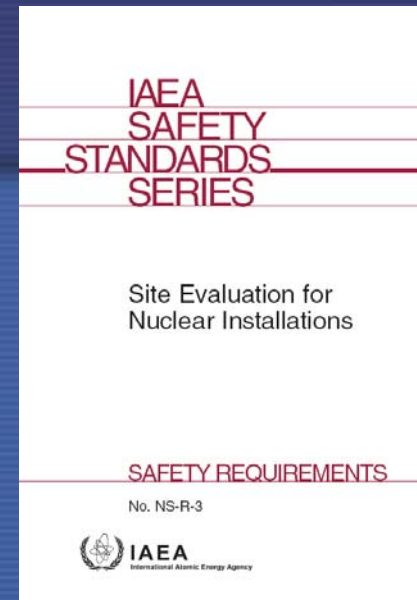
- Radiological aspects
 - Individual doses
 - Collective dose
- Emergency aspects
- Socio-economic aspects

Population Considerations

NS-R-3: Population Data

Investigation of the

- present and
- foreseeable future characteristics of the distribution of the population



NS-R-3: Population Data

Determination of the population distribution based on the most recent census data

- existing population distribution
- resident population
- transient population

Projection of population data

NS-R-3: Population Data

Consideration of

- Population living in the immediate vicinity
- densely populated areas
- population centers in the region
- residential institutions such as schools, hospitals and prisons
- tourists, nomades

NS-R-3: Population Data

The data shall be analyzed to give the population distribution in terms of the direction and distance from the plant.

An evaluation shall be performed of the potential radiological impacts of normal discharges and accidental releases of radioactive material, including reasonable consideration of releases due to severe accidents, with the use of site specific parameters as appropriate

NS-R-3: Population Data

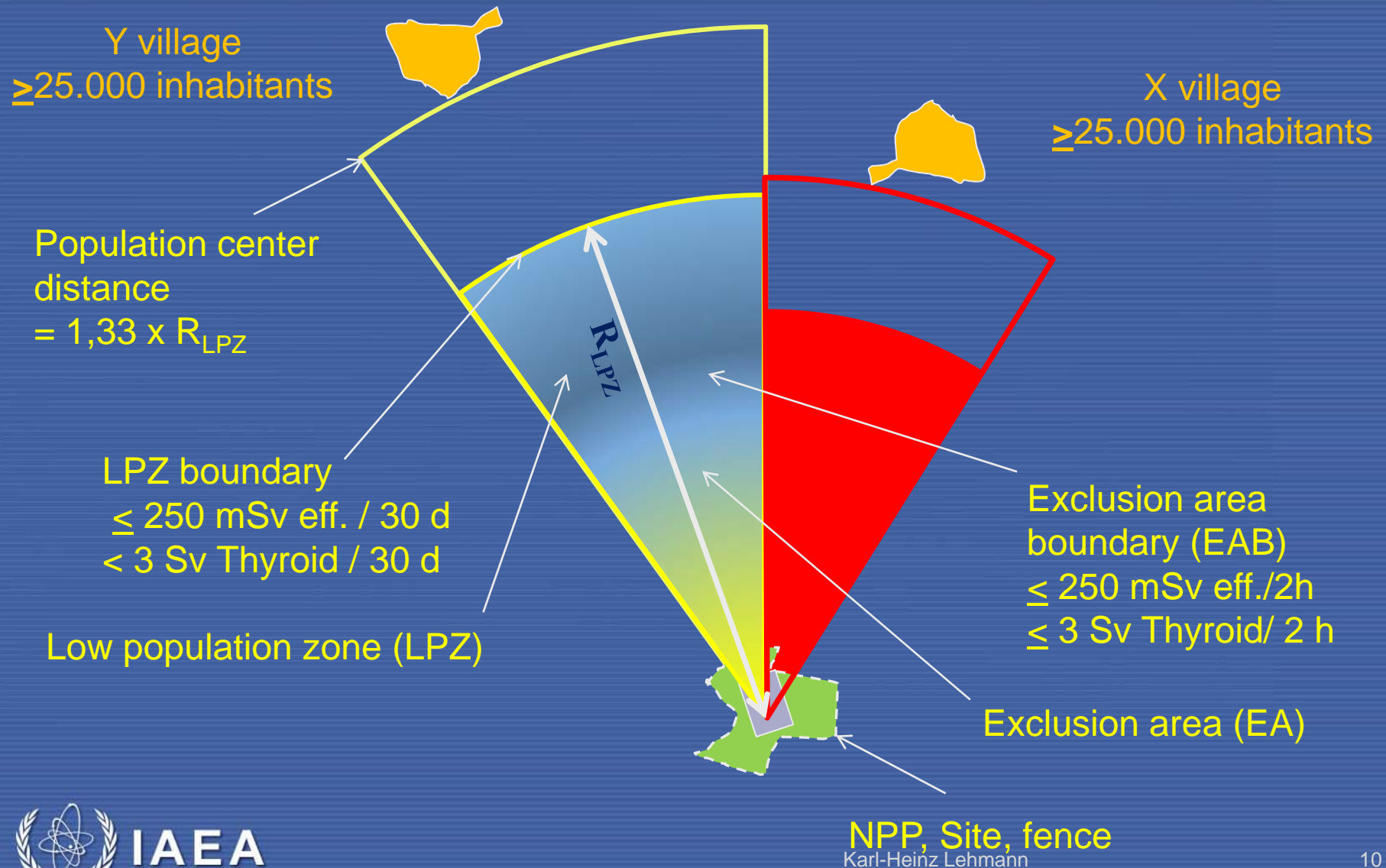
Population data should be kept to date over the lifetime of the plant

Population Considerations

Some countries are using the U.S. approach referring to Exclusion Area, Low Population Zone and Population Center Distance, see

**U.S. Code of Federal Regulations
Title 10 Part 20 and Part 100**

10CFR 100: Exclusion Area, Low Population Zone, Population Center Distance



NRC RG 4.7

Regulatory Position

up to radius of 20 mi : < 500 persons/mi²

equals to

≈ 200 persons/km² or ≈ 1 persons/acre

Feasibility of an Emergency Plan

Feasibility of an Emergency Plan

Emergency planning

- is part of the international adopted concept of defence in depth
- is not only a technical issue
- refers to national and international existing procedures and measures

Feasibility of an Emergency Plan

Stakeholders with respect to emergency planning are

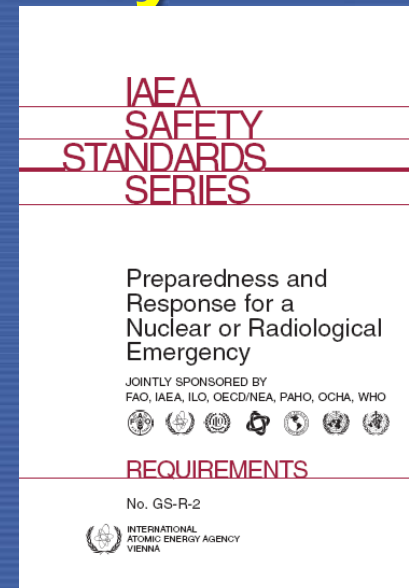
- responsible branches of the national government (nuclear, interior, transportation, health, research, ...)
- local government
- local authorities and administrations like neighbouring villages, counties, fire brigades, rescue teams
- public

GS-R-2: Preparedness and response for Nuclear and Radiological Emergency

Safety Standards Series No. GS-R-2

Preparedness and response for Nuclear and Radiological Emergency

Requirements: ...shall ...



NS-R-3: Basic Requirements

The site must allow the implementation of emergency arrangements which meet the international requirements

- **Establishing of an appropriate external zone**
- **Confirmation before start of the operation**

NS-R-3: External Zone

External Zone

The area immediately surrounding a proposed site area in which population distribution and density, and land and water uses, are considered with respect to their effects on the possible implementation of emergency measures.

Further requirements, cf. NS-R-3 para. 2.1(c),
2.29^{[NS-R-3](#)}

NS-R-3: External Zone

The extent of the external area/zone is defined by the

- feasibility of emergency measures
- range of impacts due to man induced events which have to be analysed

! c.f. definition in “Requirements”

NS-R-3: General Requirements

... aspects shall be considered:

The population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population



NS-R-3: Basic Requirements

What are the conditions of the implementation process and which aspects has to be considered?

- *Need of a regulatory basis*
- *Jurisdictions and responsibilities*
- *Impediments to response*
- *Sustainability of arrangements*

GS-R-2: Preparedness and response for Nuclear and Radiological Emergency

General Requirements

- Basic responsibilities
- Assessments of threats

Functional requirements

- Requirements for preparedness
- Requirements for response

GS-R-2: General Requirements

Basic responsibilities

- Allocation of responsibilities
- National coordinating authority responsible for response to an emergency
- Role of the regulator
- Assign responsibilities of all involved authorities clearly (depends on national legal situation)
- Role of the licensee

GS-R-2: General Requirements

Allocation of responsibilities

- Needs agreement of all stakeholders
- Establish before construction is started
- Local officials
- National authority/organization responding to “normal” emergencies
- Organizations in other countries, if affected

GS-R-2: General Requirements

Regulatory body

- Regulations and guides have to be adopted
- Emergency arrangements have to be effective before fuel is on-site
- Implementation of the arrangements to all concerned response organization
- Testing and exercising of the arrangements before start of operation

GS-R-2: General Requirements

Arrangements

- based on a threat assessment
- For all possible events, even of low probability, including conventional emergencies like earthquakes
- Consider local conditions (severe weather, floods, population location and characteristics, evacuation routes, boundaries,...)

GS-R-2: General Requirements

Assessment of threats

Threat Category	Radiological Threat
I	Severe deterministic health effects, e. g. NPP
II	Warranting urgent protection off-site, e. g. research reactors
III	No urgent protective actions off-site
IV	Minimum level of threat, warranting protective action in an unforeseeable location; applicable for all states and jurisdictions; includes non-authorized activities
V	Food contamination due to events of threat category I or II, necessitating prompt restrictions of consumption

GS-R-2: Action Levels

Action necessary under any circumstances

TABLE II-I. ACTION LEVEL OF DOSE FOR ACUTE EXPOSURE, BY ORGAN OR TISSUE

Organ or tissue	Action level of dose: Projected absorbed dose to the organ or tissue in less than 2 days
	(Gy)
Whole body (bone marrow)	1
Lung	6
Skin	3
Thyroid	5
Lens of the eye	2
Gonads	3

GS-R-2: Intervention levels

GUIDELINES FOR INTERVENTION LEVELS AND ACTION LEVELS IN EMERGENCY EXPOSURE SITUATIONS¹

URGENT PROTECTIVE ACTIONS: SHELTERING, EVACUATION, IODINE PROPHYLAXIS

III-1. The generic optimized intervention level for sheltering is 10 mSv of avertable dose in a period of no more than 2 days. Authorities may wish to advise sheltering at lower intervention levels for shorter periods or so as to facilitate further countermeasures, e.g. evacuation.

III-2. The generic optimized intervention value for temporary evacuation is 50 mSv of avertable dose² in a period of no more than 1 week. Authorities may wish to initiate evacuation at lower intervention levels for shorter periods, and also where evacuation can be carried out quickly and easily, e.g. for small groups of people. Higher intervention levels may be appropriate in situations where evacuation would be difficult, e.g. for large population groups or if there is inadequate transport.

III-3. The generic optimized intervention value for iodine prophylaxis is 100 mGy of avertable committed absorbed dose to the thyroid due to radioiodine. [See Addendum to Annex III.]

GS-R-2: Intervention levels

In some countries a value of 100 mSv of avertable dose is considered to be a more realistic level for temporary evacuation.

The ICRP has recommended that evacuation would almost always be justified for an avertable dose of 500 mSv (or equivalent dose to the skin of 5000 mSv), and that the range of optimized values would be lower than this by no more than a factor of ten (see ICRP Publication 63 (footnote 42), p. 23).

General recommendations are given in ICRP, Principles of Monitoring for the Radiation Protection of the Population, ICRP Publication No. 43.

Nomogramm Referenznuclid *I 131

Legende:

- früh: Freisetzung 6 Std. nach Abschalten des Reaktors
- spät: Freisetzung 120 Std. nach Abschalten des Reaktors
- naß: Veränderung des Nuklidgemischs durch Regen
- trocken: trockene Ablagerung während des Lufttransports
- spät: Ablagerung während des Lufttransports mit Regenintensität von 1 mm/h

Dosis in [mSv] durch:

- Gamma-submergen
- Inhalation
- Haut (24 h)
- Zeitinteg. Luftkonzentration [Bq·h/m³]
- Bodenkontamination [Bq/m²]
- Boden, 7 Tage
- Boden, 1 Jahr

Evakuierung

Aufenthaltsort

langfristige Umsiedlung

gilt nur im Fernbereich

Protection Factors

Table 4.2: Protection Factors for External Exposure in Residential Areas

Whereabouts	Protection factors for external exposure in residential areas	
	from radioactive cloud ²⁾	shortly after deposition
Outdoors		
Areas with vegetation (trees)	1.0 – 1.4	0.6 ³⁾ – 2.0
Urban environments with neighbouring buildings, without vegetation (trees)	1.2 – 3.3	3.3 – 10
In living rooms of ¹⁾		
Prefabricated houses	1.2 – 10	1.2 – 2.5
Semidetached houses and terraced (row) houses	1.2 – 10	3.3 – 50
Multi-family buildings and blocks	10 – 200	25 – 1000
In basement rooms ¹⁾		
With windows above ground level	10 – 1000	20 – 100
Without windows, semi-detached house	10 – 1000	330 – 5000
With light wells and windows, in blocks	500 – 10000	1000 – 20000

- 1) The protection factors are calculated without any contamination of interiors. If the surface contamination of floors, walls and ceilings is approximately 1 percent of the contamination of fields, the actual protection factor is reduced to about 100 and is thus much lower than shown in the table for well screened rooms.
- 2) Estimate based on homogeneous distribution of radioactivity in the atmosphere.
- 3) Protection factors less than 1 are due to the increased deposition on trees under dry deposition conditions.

GS-R-2: Functional Requirements

In total 89 Functional “Requirements” (...shall...) in 12 groups cover the following topics

- (1) Establishing emergency management and operations (10)
- (2) Identifying, notifying and activating (20)
- (3) Taking mitigatory action (9)
- (4) Taking urgent protective action (12)
- (5) Providing information and issuing instructions and warnings to the public (3)
- (6) Protecting emergency workers (10)

GS-R-2: Functional Requirements (contd.)

- (7) Assessing the initial phase (8)
- (8) Managing the medical response (8)
- (9) Keeping the public informed (3)
- (10) Taking agricultural countermeasures,
countermeasures against ingestion and longer
term protective actions (9)
- (11) Mitigating the non-radiological consequences of
the emergency and the response (3)
- (12) Conducting recovery operations (4)

GS-R-2: Functional Requirements (contd.)

Major – and most exciting – task of the stakeholders:

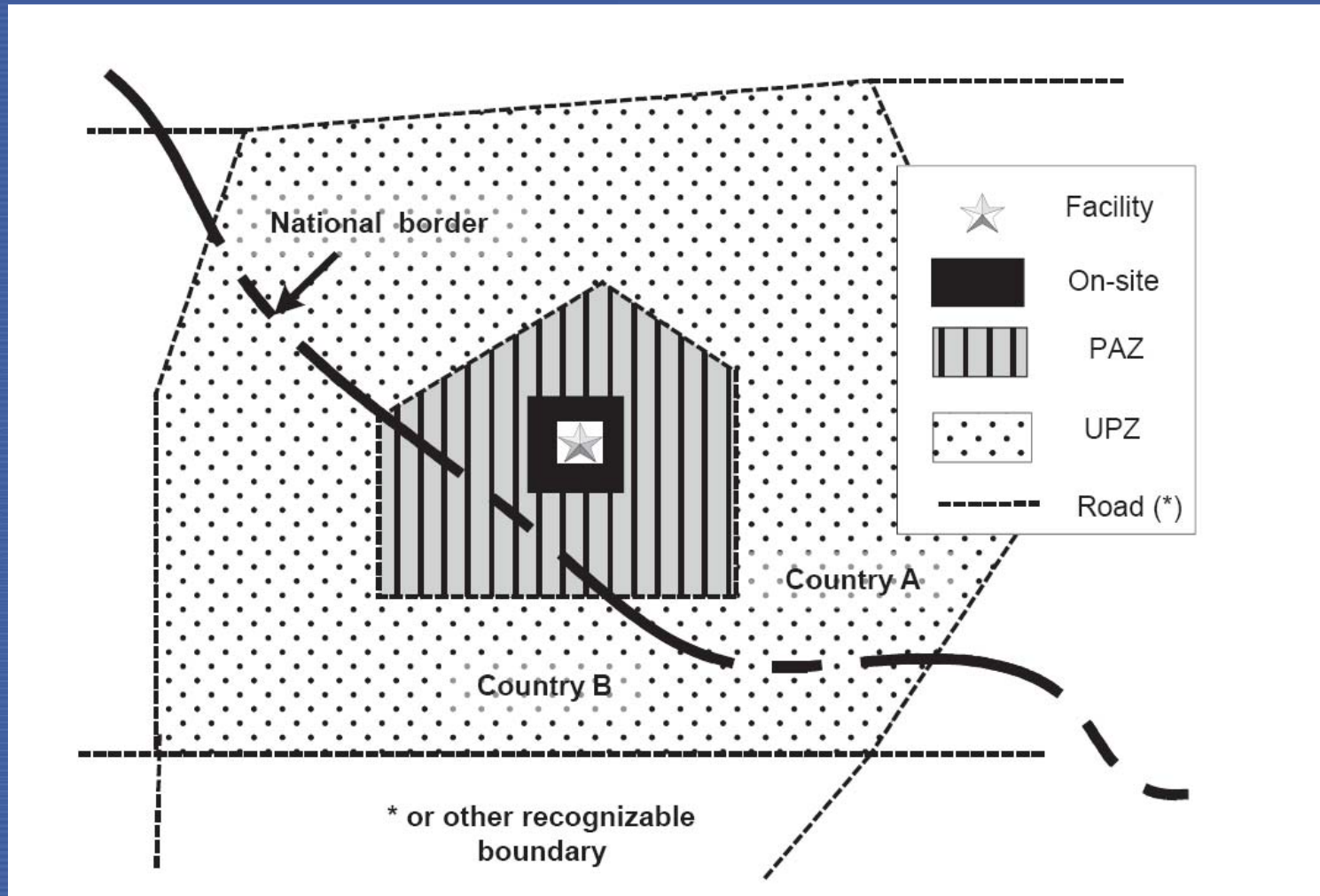
Allocation of the responsibilities for the functional requirements

Emergency Arrangements

Areas and Zones according to Safety Guide GS-G-2.1 ← “...should...”

- On-site area (under control of the licensee)
- Precautionary actions zone (PAZ)
- Urgent protective action planning zone (UPZ)

GS-G-2.1: Areas and Zones



On-site Area

- Under control of the licensee
- only utility staff on-site or persons, which are involved in operation of the plant (e. g. contractors, visitors), i. e. workers only
- Prompt protection measures should be defined

Precautionary Actions Zone (PAZ)

- Actions taken before a release of radioactive material occurs or shortly after the release of radioactive material
- Promptly (15 min.) decision making
- Promptly notify the public (15-30 min.) and recommend protective actions
- Provisions for sheltering or evacuation

Urgent Protective Action Planning Zone (UPZ)

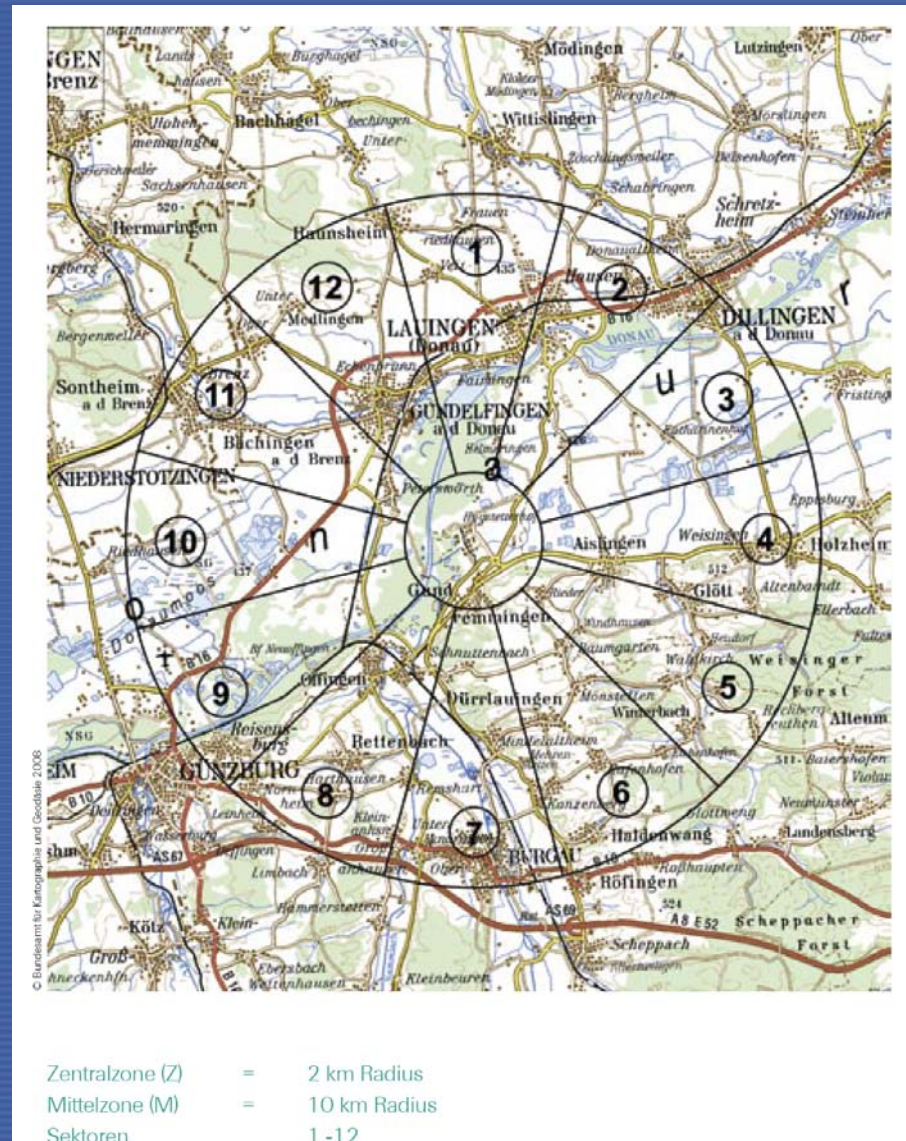
- Prompt notification of the public to shelter and listen for further information (1 hr.)
- Monitoring of the environment and decide upon further protective measures (4 hrs.)
- Provision for future sheltering or evacuation

GS-G-2.1: Areas and Zones

Recommended Size of the zones

Facility		PAZ radius [km]	UPZ radius [km]
Reactor	> 1.000 MW (th)	3-5	25
Reactor	> 100, < 1.000 MW (th)	0,5-3	5-25

Information of the Public



GS-G-2.1: Urgent Protective Actions

Typical urgent protective actions

- In the case of radiological emergencies, isolation of a contaminated area or radioactive source
- Prevention of inadvertent ingestion
- Evacuation
- Sheltering
- Respiratory protection and protection of skin and eyes
- Decontamination of individuals
- Prophylaxis with stable iodine
- Protection of the food supply and prevention of the consumption of significantly contaminated foodstuffs and water
- Management of the medical response
- Protection of international trade

GS-G-2.1: Functional Requirements

In total 54 Functional “Requirements” (...should...) cover the following topics

- Identifying, notifying and activating
- Taking urgent protective actions and assessing the initial phase
- Keeping the public informed
- Managing the medical response
- Taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions
- Mitigating the non-radiological consequences of the emergency and response
- Other actions

International Atomic Energy Agency



Thank you for your attention

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