

Toolkit for Establishing Laws to Control the Use of Lead in Paint

# Module Bi & Bii

## Health and Environmental Hazards of Lead

Adapted for: East Africa Workshop on the Development of National and Regional Regulations and Standards on Lead in Paints, 13-14 September 2016, Dar es Salaam, United Republic of Tanzania



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# Outline

- Sources of lead release
- Sources and routes of exposure to lead from paint
- Health effects in humans
- Who is at risk?
- Societal impact of lead
- Environmental impacts of lead
- Summary

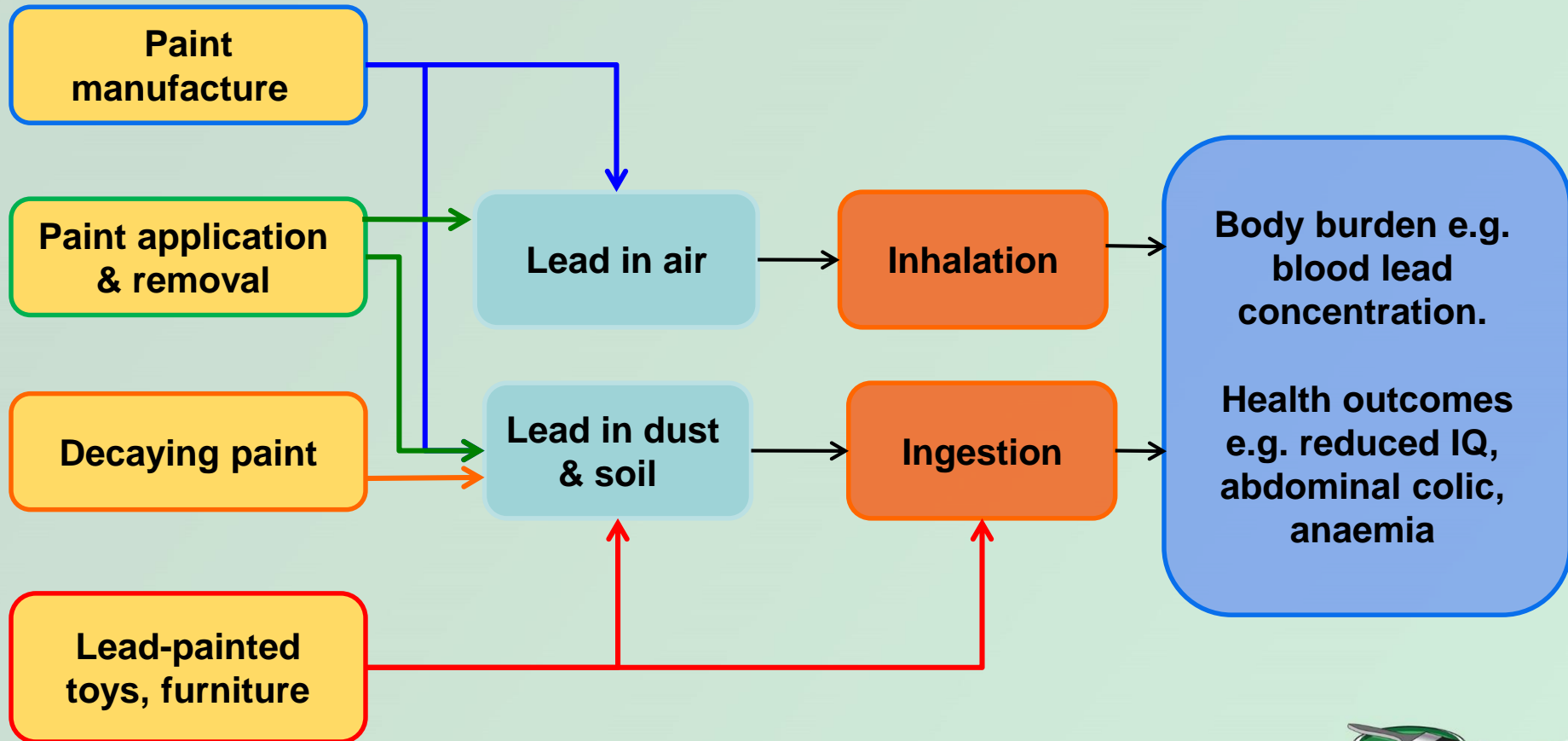


# Sources of lead release

- Natural (volcanic, weathering of rocks)
- Anthropogenic sources:
  - mobilization of lead in raw materials such as fossil fuels and other extracted and treated ores and metals
  - direct releases from waste to soil and aquatic environments
  - releases during the manufacture, use and disposal of products using lead (e.g. **paint**, batteries, toys)
    - prior to the removal of lead from gasoline in most countries, leaded gasoline was a significant source of lead
- Lead is mainly emitted in particle form, is transported through the atmosphere and settles on soil, plants, water etc



# Multiple pathways of exposure to lead from paint



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# Ingestion is an important route of exposure for children

- Children may ingest contaminated dust and paint chips
- Children with pica are at particularly high risk – severe poisoning may occur
- Picture is a radiograph of a child with lead poisoning from eating lead paint, showing paint chips (white spots) dispersed throughout the gut



Figure 2 – A large quantity of lead paint chips can be seen in this radiograph of the abdomen and pelvis of a 2-year-old boy with lead poisoning.

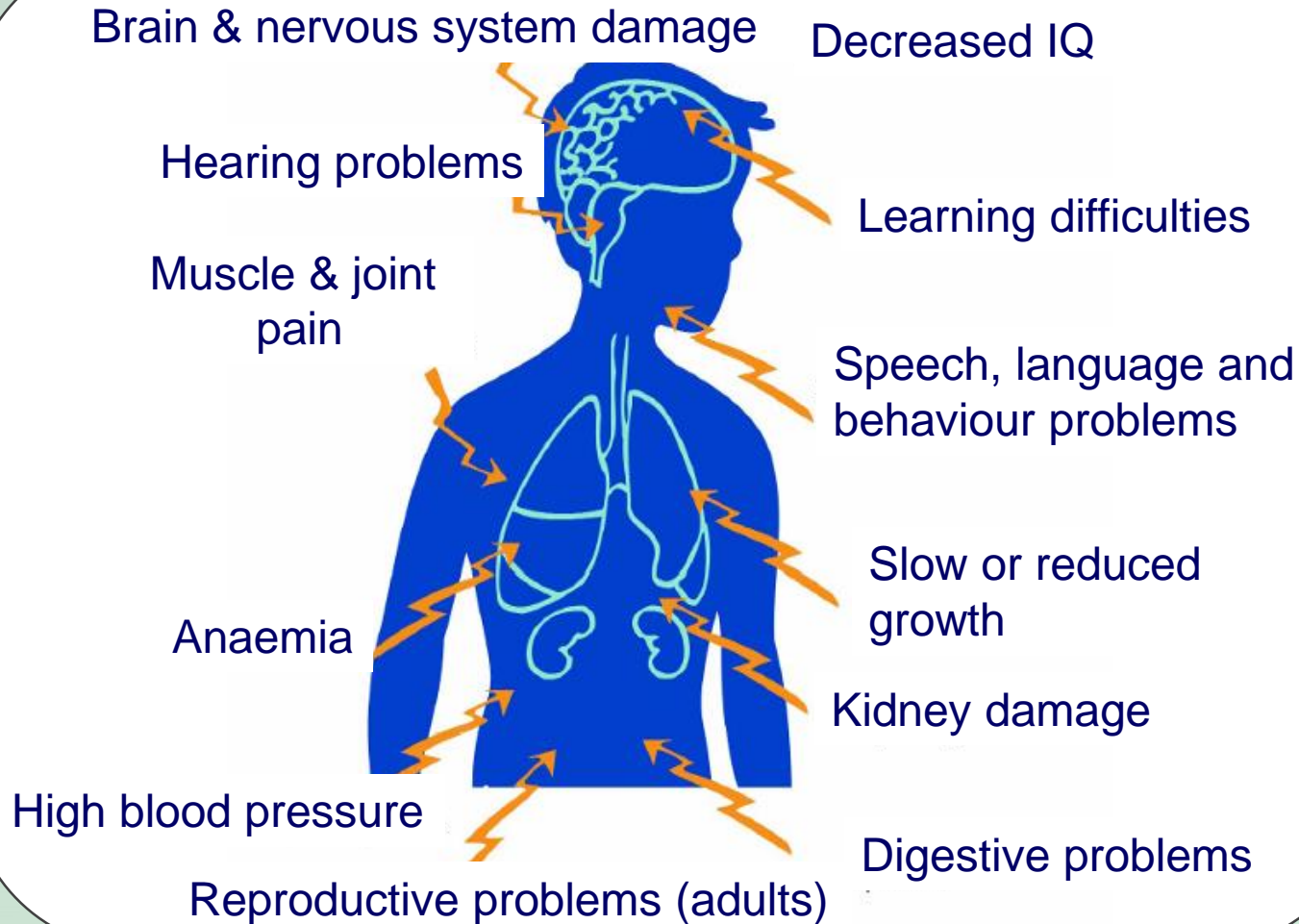


# Lead accumulates in the body

- Bound to red blood cells and distributes to soft tissues, e.g. brain and kidneys, and to bone
- Stored in bone for many years (half-life = 10 – 25 years)
- Lead in bone provides a pool from which lead can move back into blood and to target organs
  - e.g. during pregnancy, lactation and the menopause



# Lead is a multi-system toxicant



# No known threshold for toxic effects – US National Toxicology Program assessment of evidence

Table 1.1: NTP conclusions on health effects of low-level Pb by life stage

Life Stage	Blood Pb Level	NTP Conclusion	Principal Health Effects	Bone Pb Evidence
Children	<5 µg/dL	<i>Sufficient</i>	Decreased academic achievement, IQ, and specific cognitive measures; increased behavior problem behaviors	Tibia and dentin Pb are associated with attention-deficit and cognition.
		<i>Limited</i>	Delayed puberty, IQ, and decreased hearing	Children does not show growth.
	<10 µg/dL	<i>Sufficient</i>	Delayed puberty, IQ, and decreased hearing	
		<i>Limited</i>	Increased hypersensitivity to allergens and increased IgE	
		<i>Inadequate</i>	Any age – asthma, eczema, cardiovascular disease	
Adults	<5 µg/dL	<i>Sufficient</i>	Increased fetal loss, reduced fetal growth	In the general population, bone Pb and blood Pb are associated with reduced fetal growth.
		<i>Limited</i>	Increased incidence of essential tremor	No data
	<10 µg/dL	<i>Sufficient</i>	Increased blood pressure, increased risk of hypertension, and increased incidence of essential tremor	The association between bone Pb and cardiovascular effects is more consistent than for blood Pb.
		<i>Limited</i>	Psychological effects, decreased cognitive function, decreased hearing, increased incidence of ALS, and increased cardiovascular-related mortality; maternal blood Pb associated with increased incidence of spontaneous abortion and preterm birth	The association between bone Pb and cognitive decline is more consistent than for blood Pb.
		<i>Inadequate</i>	Immune function, stillbirth, endocrine effects, birth defects, fertility or time to pregnancy**, sperm parameters**	No data

<5 µg/dL  
 Decreased academic achievement & IQ, & increased problem behaviours  
 Effects on kidney, reduced fetal growth

**Abbreviations:** ALS, amyotrophic lateral sclerosis; IgE, immunoglobulin E; IQ, intelligence quotient

\*Increased serum IgE is associated with hypersensitivity; however, as described in Section 1.4.3, increased IgE does not equate to disease.

\*\*The NTP concludes that there is *inadequate* evidence that blood Pb levels <10 µg/dL are associated with fertility, time to pregnancy, and sperm parameters; however, given the basis of the original nomination, the NTP evaluated the evidence that higher blood Pb levels (i.e., >10 µg/dL) are associated with reproductive and developmental effects, and those conclusions are discussed in Section 1.4.6 and presented in Table 1.2.

(Reference 2)



# Who is at risk? Children

- Children have greater exposure:
  - play on the ground, hand-to-mouth activity, mouthing objects
  - absorb 4-5 times more lead from the gut than adults
- Fetal period and early childhood are critical periods for neurological and other organ development
- Damage to the neurological system may be permanent
  - reduces a child's potential for intellectual development
  - increases the likelihood of behavioural disorders



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# Who is at risk? Pregnant women

- Pregnancy mobilizes lead stored in bone, releasing it back into blood where it can be circulated to maternal tissues and the fetus
- Increased risk of hypertension during pregnancy – may be greater risk of pre-eclampsia
- Exposure of pregnant women can result in exposure of the fetus – may cause reduced fetal growth

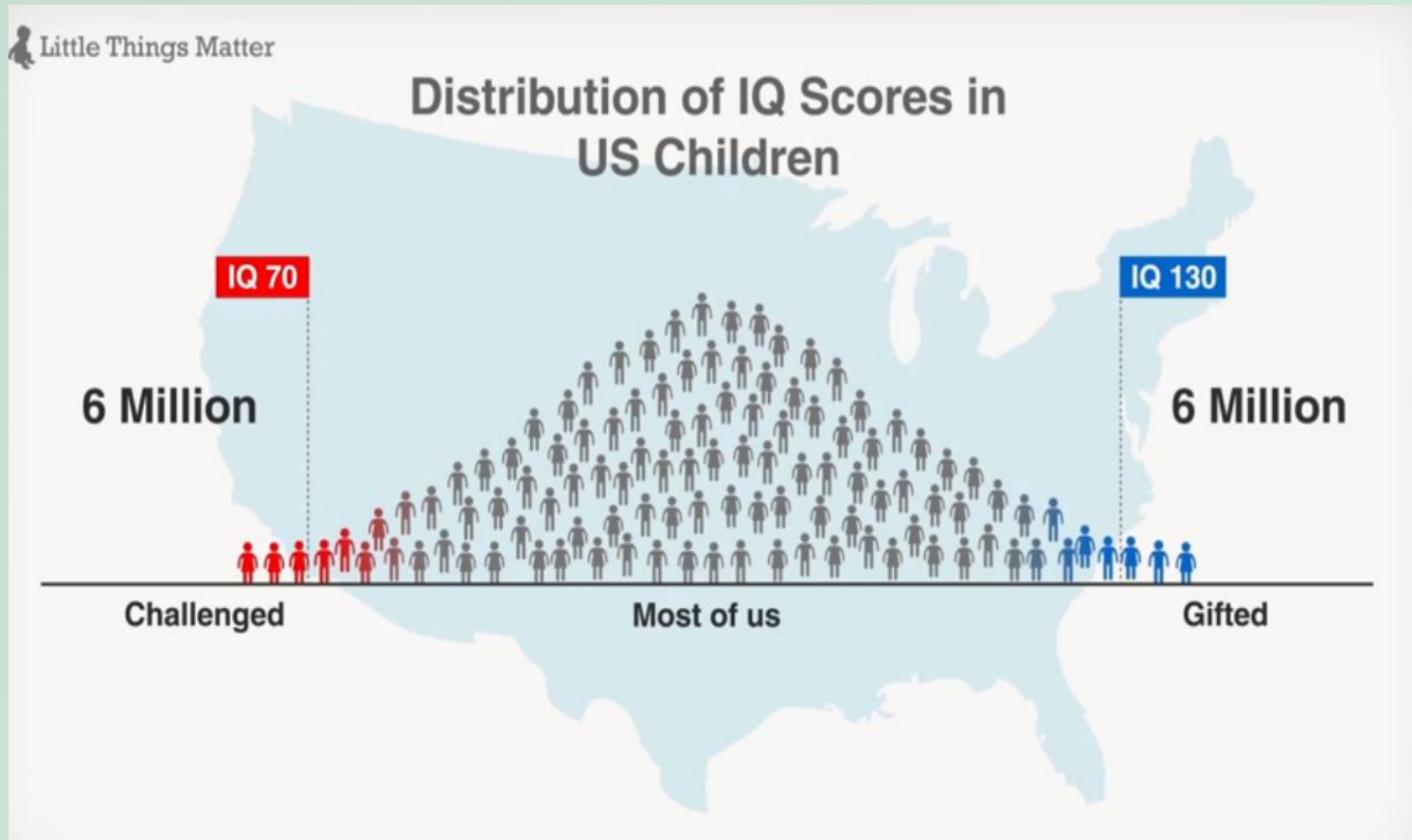


# Lead causes significant burden of disease

- 853,000 deaths in 2013 from long-term effects
- Estimated to account for:
  - 9.3% of the global burden of idiopathic intellectual disability
  - 6.6% of the global burden of stroke
  - 4% of the global burden of ischaemic heart disease

(estimates by Institute for Health Metrics and Evaluation 2015)

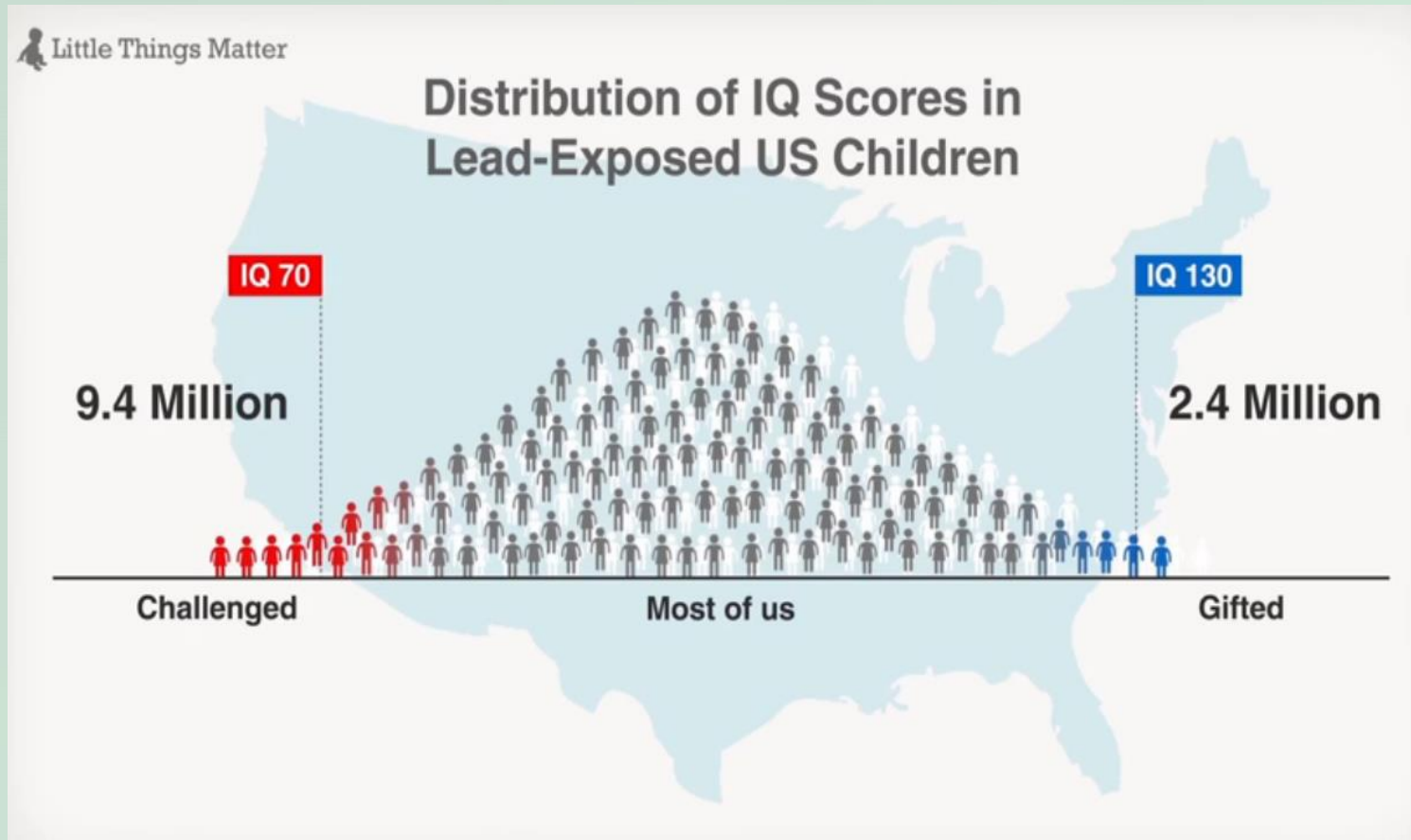
# Small IQ reduction has significant societal impact (mean IQ 100)



(Reference 4)



# Small IQ reduction has significant societal impact (mean IQ 95)



# Environmental impacts of lead



# Impacts on the ecosystem

- Terrestrial exposure to lead is greatest near point sources (e.g. smelters)
- Plants absorb lead from the soil and retain most of the lead in their roots
- Aquatic exposure to lead is strongly dependent on environmental conditions (pH, salinity, etc)
- Lead bioaccumulates in organisms, in particular those that feed primarily on particulate matter
- Secondary poisoning may occur e.g. in predators feeding on contaminated animals



# Impacts on organisms

- Effects on micro-organisms from soil with lead concentrations as low as 10 mg/kg (10 ppm)
- Ingestion of lead-contaminated bacteria and fungi by nematodes can cause impaired reproduction
- In higher animals lead is shown to damage multiple organ systems (blood, central nervous system, kidneys, reproductive & immune systems)
- Fish can develop spinal deformity and blackening of the skin in the caudal region (black tail)
- Birds may be poisoned by eating lead shot and sinkers





# Summary

- Lead exposure causes toxic effects in multiple body systems; some effects are permanent
- There is no known level of lead exposure that is considered safe
- Lead exposure has both a personal and a societal impact
- Lead has negative environmental impacts

# Additional information

- More information and references are in the **Toolkit for Establishing Laws to Control the Use of Lead in Paint**  
<http://web.unep.org/chemicalsandwaste/noleadinpaint/toolkit>
- Module Bi Health hazards of lead (WHO)
- Module Bii Environmental impact of lead (UNEP)

