Preliminary Consideration about the Safety Design of the ILC Accelerator Tunnel

Personal safety and Disaster Prevention Facilities

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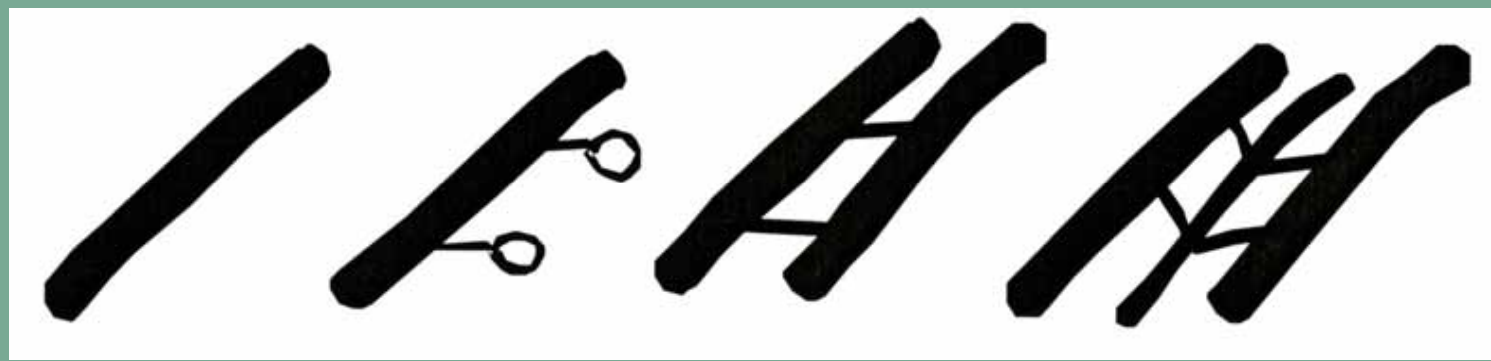
Introduction

- ***Background* from the *Past Failure Examples* in the Large-scale Underground Space**
- ***Status* in using *Large Depth Underground* Spaces for an Accelerator Facility**
- ***Issues* of finding the Most Suitable Design for the *Single Tunnel Configuration***



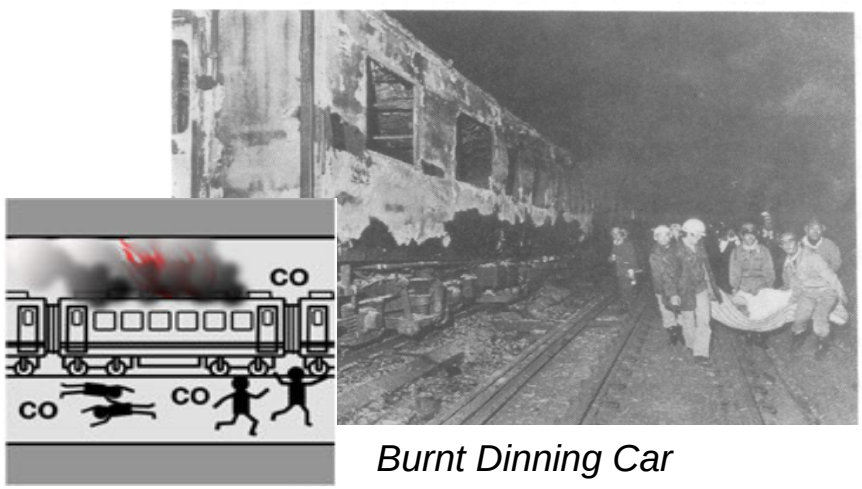
Outline

- Introduction
- Background from Examples of Past Failures
- Status of KEK Accelerator Facilities
- Issue of Safety Measures in a Single Tunnel
- Summary

① Background from Past Accident ②

HOKURIKU Tunnel Fire In 1972

- Dead: 29 Injured: 719
- Cause: Train Fire (Dinning car)
- Factors Causing Damage Expansion
  - ●Train stopped in Tunnel (in Darkness)
  - ●No Smoke Facilities or Emergency Illumination etc
  - ●Status Report to Passengers delayed several Hours



Burnt Dinning Car

NIHONZAKA Tunnel Fire in 1979

- Dead: 7 (180cars were burnt)
- Cause: Collision (During Traffic Jam)
- Factors Causing Damage Expansion
  - ●Fire Hydrant, Sprinkler ; Lack of Water Pressure and Quantity
  - ●False Report Delayed Help
  - ●Evacuation Exit ; 500m Intervals

③ Background from the Past Accident ④

The Subway Fire in KOREA in 2003.

- Death toll: 194 peoples
- Cause: Terrorist Arson
- Factors Amplifying Damage

●Most Emergency Facilities Broke Down

●Sprinkler did not Function Adequately

●Evacuation Route was obstructed by Smoke



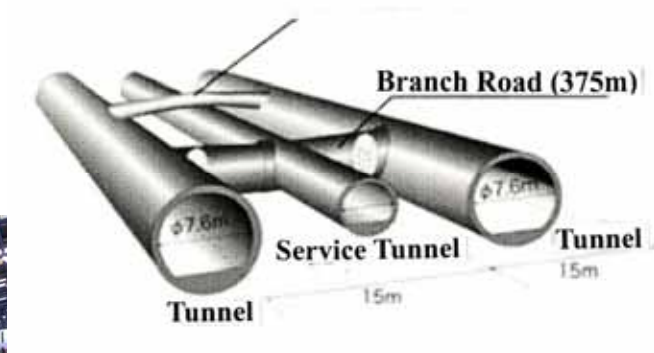

The Euro-tunnel Fire in 1996.

- Casualties : 0
- the Cause: Vehicle Fire
- Factors Reducing Damage

●All Emergency Facilities Operated

●Service Tunnel Shelters

● Rescue Operation was Deployed According to the Manual



What Should We learn from Past Experience ?

From the Background

- ***Various Causes of Disasters Requiring Evacuation ;***
  Terrorism, Fires, Electric Power Failure caused by Earthquake, Helium-gas Leak

- ***Distance to a Safe Place is the Most Critical Factor in Evacuation from Underground Spaces***

- ***In Almost All Cases, Rescue Teams needed Several Hours to Access those trapped***

- ***It is Necessary to consider Human Escape Behavior in designing Emergency Facilities***

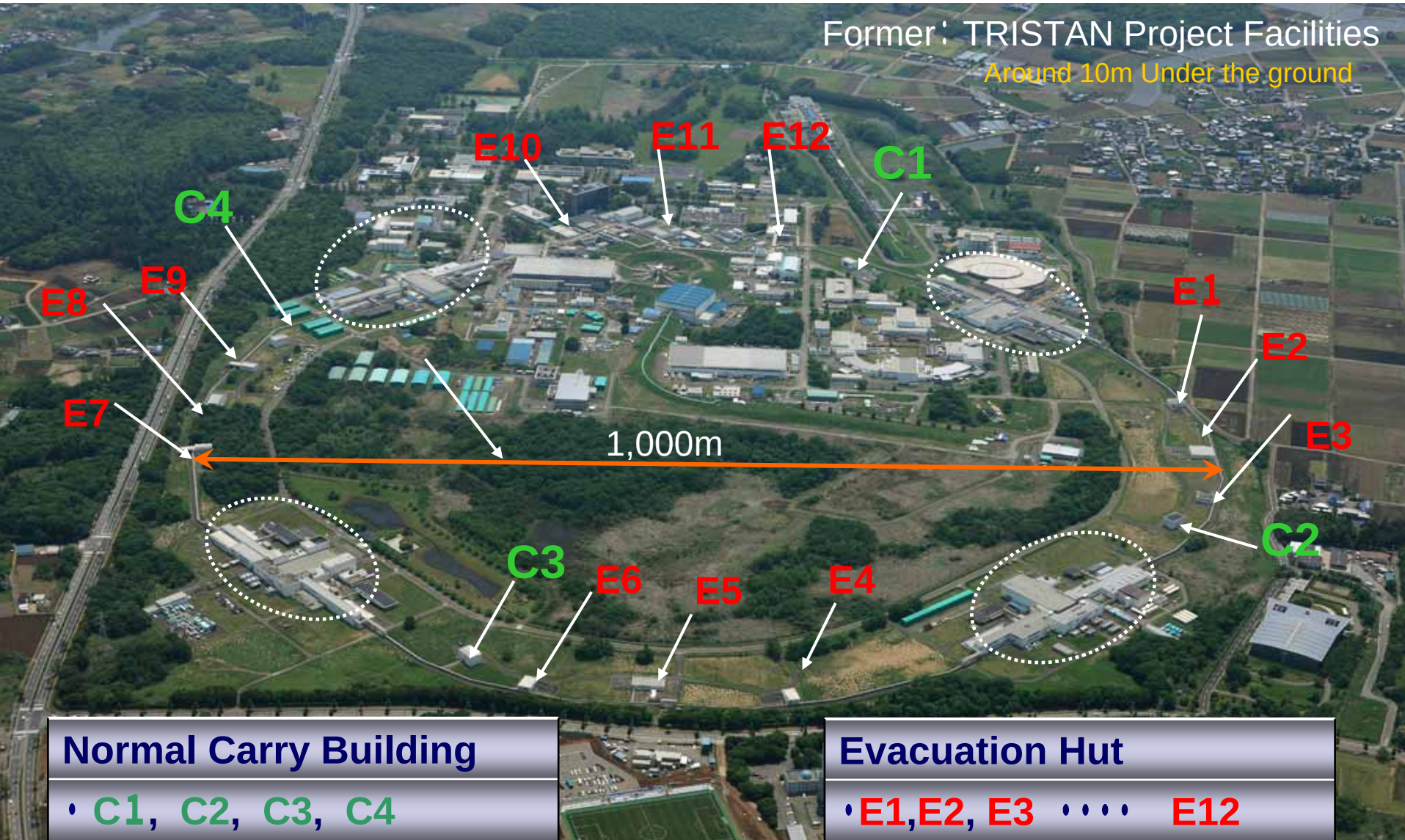
Status of the Tunnel Disaster Prevention in Japan

■ : Set by National Standard ● : Arbitrary Set by KEK

Disaster Prevention Facilities		General Tunnel			Accelerator Tunnel (in KEK)	
		Road	Railway	Utility		
Report/ Warning	Emergency Phone	■	■	×	●	
	Emergency Alarm	■	-	×	●	
	Fire Alarm	■	-	×	●	
Fire-Fighting	Fire Extinguisher	■	-	■	■	*By Fire-fighting Law*
	Fire Hydrant	■	-	×	×	■ Experiment hall
	Water Spray	■	■	×	×	■ Experiment hall
Refuge-Instruction	Evacuation Route	■	■	×	●	To Stairs <400m
	Smoke-Facilities	■	■	×	×	■ Experiment hall
	Emergency Illumi.	■	■	×	●	
Others	Emergency Broad.	■	■	×	●	
	Fire Limit Division	-	■	×	■	*By Fire-fighting Law*

Example 1: $E^- E^+$ Synchrotron of KEKB

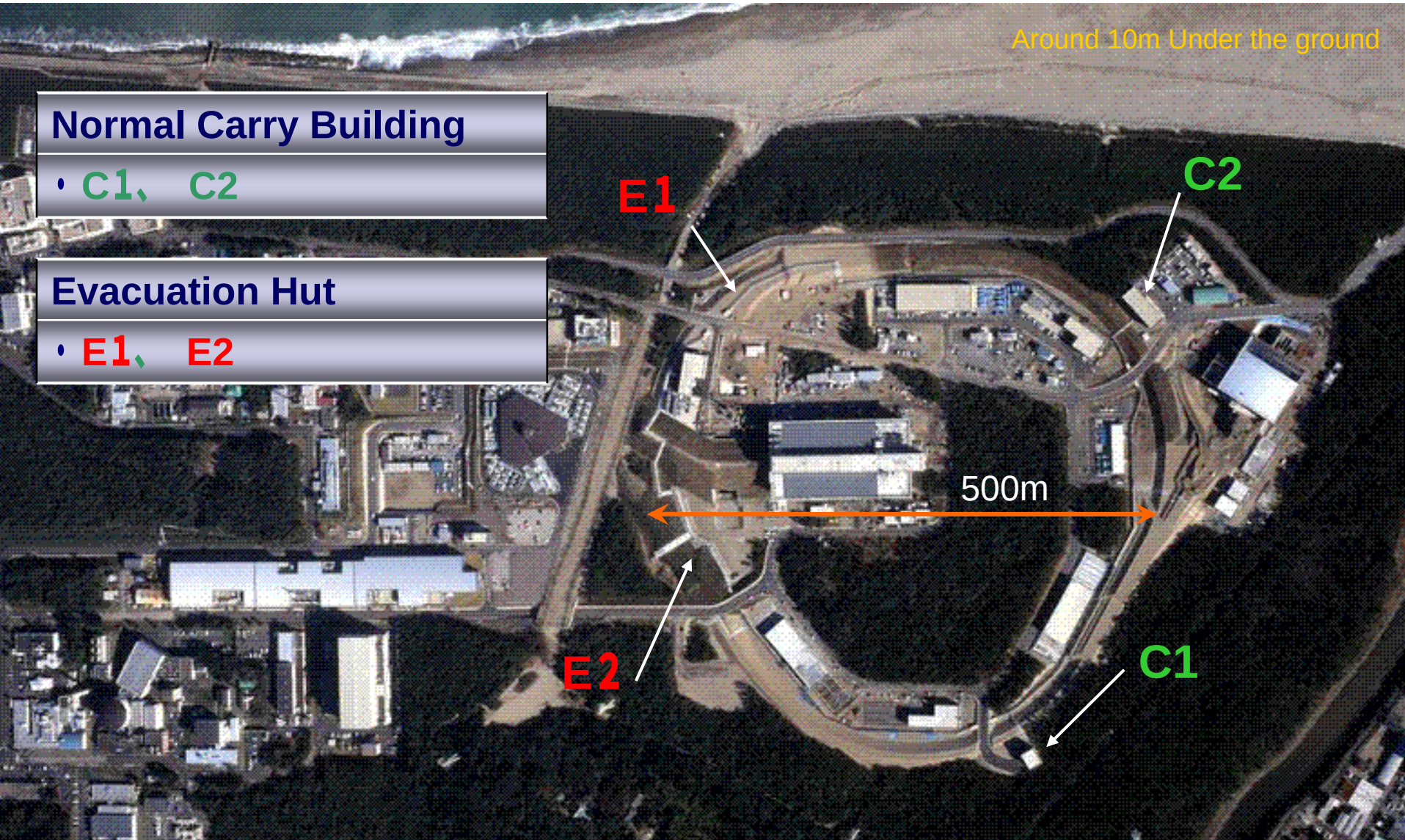
Evacuation Exits : Less than 200m Intervals



Normal Carry Building	Evacuation Hut
・C1, C2, C3, C4	・E1,E2, E3 ・・・・ E12

Example 2: 50GeV Synchrotron of J-PARC

Evacuation Exits : 400m Intervals



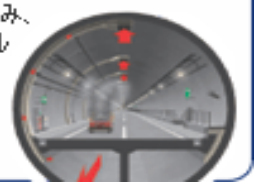
The Disaster Prevention Facilities in the Latest Tunnel

5. Water splay

管制室からの遠隔操作により、約50mの範囲に霧状の水を放水し、火災の延焼や拡大を防ぎます。

7. Smoke Outlet

吸い込み、トンネル外へ排出します。



2. Monitor Camera

約100mの間隔で設置し、常にトンネル内を見守っています。火災時には自動的にその場所の状況を管制室に映し出すとともに、トンネル内の走行状態の異常を画像処理により管制室に通知する機能を有しています。

4. Fire Detector

約25 m間隔で設置しています。火災時に発生する赤外線を自動的に検知し、管制室にいち早く知らせます。

9. Emergency Alarm

約50mの間隔で設置。
火災または非常時にボタンを押すことで、管制室へ通報できます。

6. Warning Board

非常時にトンネル内の火災・事故等の情報をドライバーにお知らせします。トンネル入口、トンネル内に設置します。

新規導入設備

10. Emergency Call

約100mの間隔で設置。
非常時に管制室と連絡をとることができます。

11. Emergency Exit

350m以内に設置されている非常口から地上出口まで避難することができます。

Regulation of Safety Measures in Japan

- ***Surface Facilities will be designed in accordance the Laws***
  (Building Standard Law / Firefighting Law / Labor and Safe Law)

- ***Accelerator Tunnel has not been Regulated by a Law***
  But, If the Underground Space is connected to the Surface Building above it, It is Regulated by the Laws

- ***A Special Law Established in 2001 is applied for the Facilities in the Large Depth Underground Space***
  (Does this include ILC Tunnels ?)
  (a Special Measures Law about the Public Use in the Large-Depth Underground Space)

Provision in the Law Defined the ILC Tunnels

Case of Road Tunnel

Emergency Facilities Setting Standard / Based on Road Law

The Setting of a Exclusive Evacuation Passage is the Duty in the Large-scale Tunnel more than 3 Km in Length

Case of ILC Tunnel

(established in 2001)

Government Policy / Based on Special Law

The Safety Security is an Important Issue before Human Activity should be allowed in any Large Deep Underground Space

1. Fire / Explosion :	2. Earthquake :	3. Flooding :
4. Power Failure :	5. Rescue Operation :	6. Crime Prevention :

Risk Assessment Example :

The relation between the Distance to Schelter and Permissible Time

		A	B	C	D	
		Second	Several Minutes	Dozens of Minutes	Several Hours	Permission Time
		Exposion	Proximity Fire	Inferno Large Fire	Earthquake Breakout	Accident Kind
Distance	Walk Time					
50m	1min	*Impossible*	*Possible*	*Possible*	*Possible*	Possibility of Refuge
500m	6–14min	*Impossible*	*Border*	*Possible*	*Possible*	
1000m	12–29min	*Impossible*	*Impossible*	*Border*	*Possible*	
5000m	60–144min	*impossible*	*impossible*	*impossible*	*Possible*	

This Study Suggests the Following:

- The Urgency of Disaster Situation and Distance to the Safe Shelters or Exits Determine the Success or Failure in Evacuation
- The Time Required for the Rescue to Access Escapes is Critical, Particularly in Case of Imminent Danger

Some Issues of Safety Measures

Evacuation Measures for the Single Tunnel Configuration

- **Can we Secure Equal High Level Safety in the case of the Twin-tunnel with the Evacuation Passage ?**

- **We should search the Optimum Safety Standard to be applicable to the Single Tunnel Plan**

Proposal a Risk Assessment

- **We Need to Develop the Concept of Safety Measures for the Agreement Formation about the Security**

- **We Propose a Risk Assessment to Estimate the Factor that will decide the Success or Failure of Evacuation**

Summary

- **We should always keep in mind that Safety Measures are extremely Important in Designing the ILC Tunnel.**
  – We must never Sacrifice the Personal Safety to reduce the Cost –

We Need to :

- **Employ established Risk Assessment Methodologies that have prevented Accidents, and restricted Damage from Disaster**
- **Create Safety Design Criteria specialized for ILC Facilities in early Planning Stage**