



轨道交通控制与安全

国家重点实验室(北京交通大学)

STATE KEY LAB OF RAIL TRAFFIC CONTROL & SAFETY

The Practical Safety Management for Chinese CBTC Development

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Main Content

1. Introduction

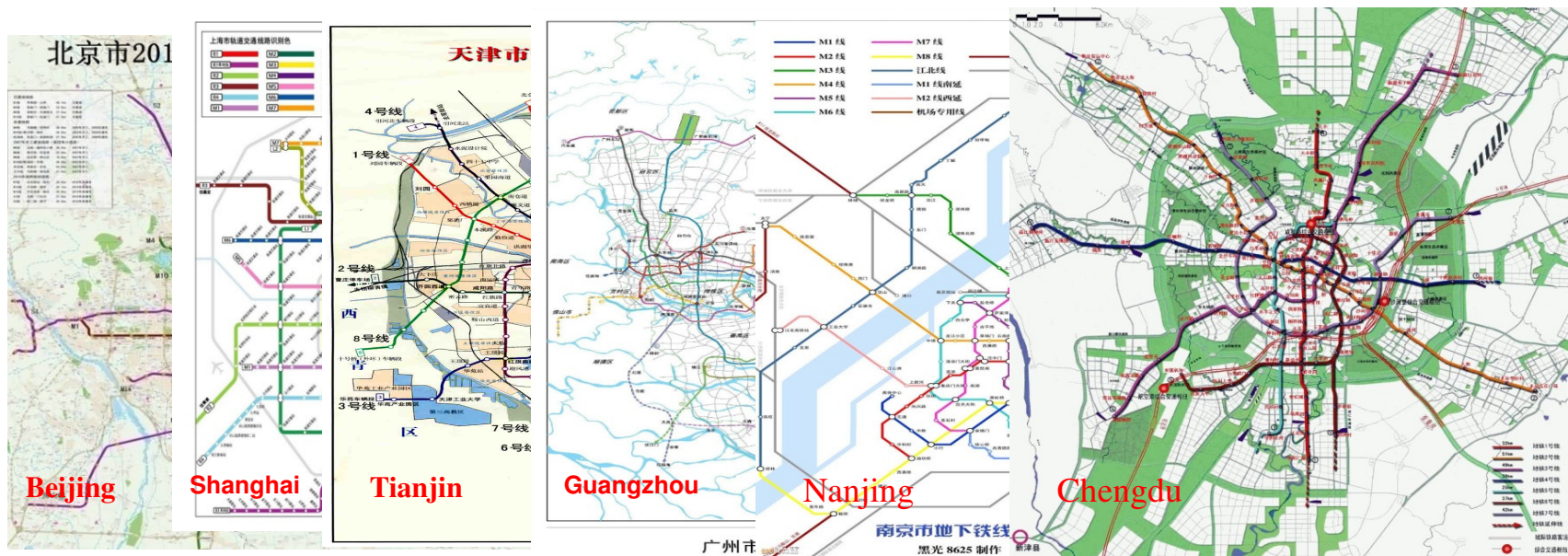
2. The Development of CBTC

3. The Safety Management System of CBTC Development

4. Conclusion

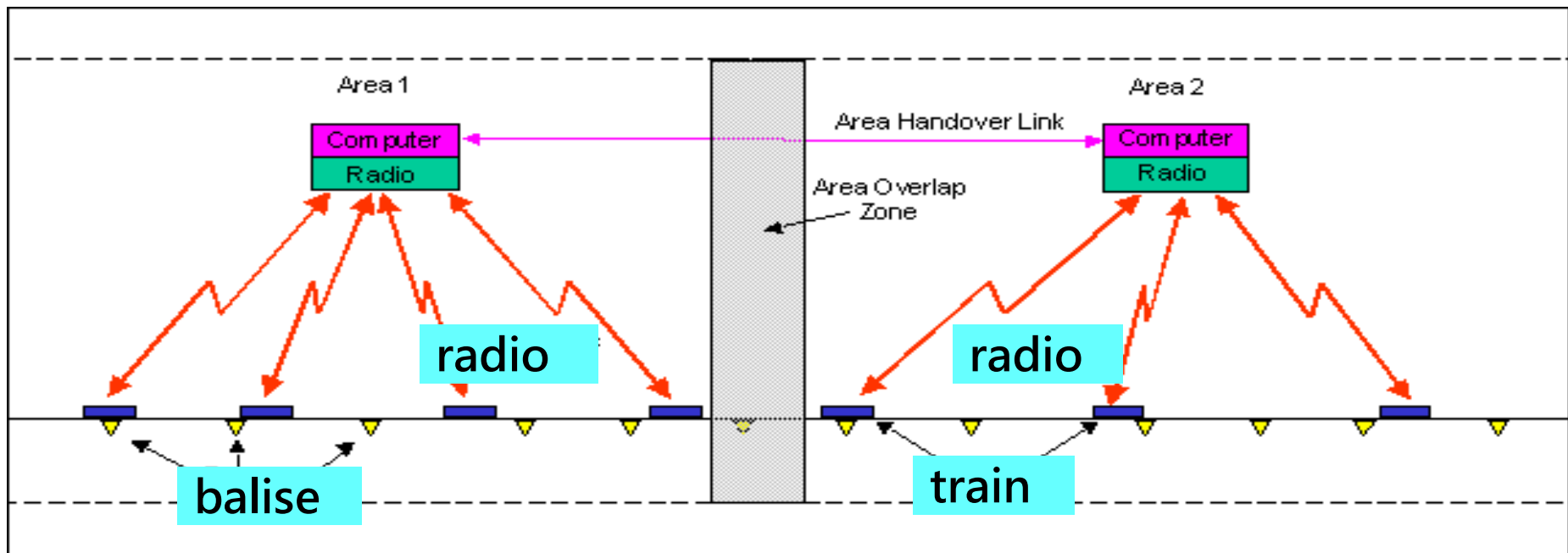
Urban Transit Development In China

- Many urban transit lines is under construction now in about 25 cities including Beijing, Shanghai, Guangzhou and so on.
- Before 2015, about more than 4000 Km lines will be built.



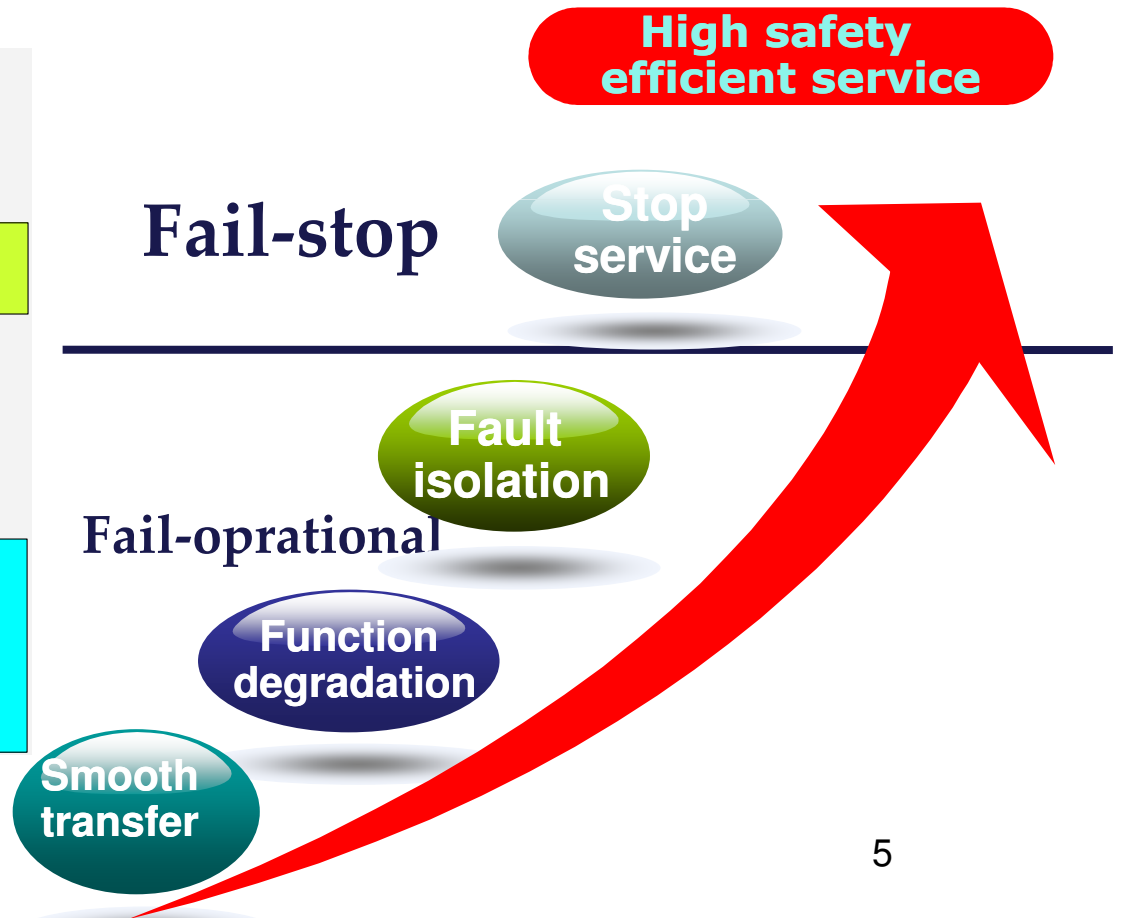
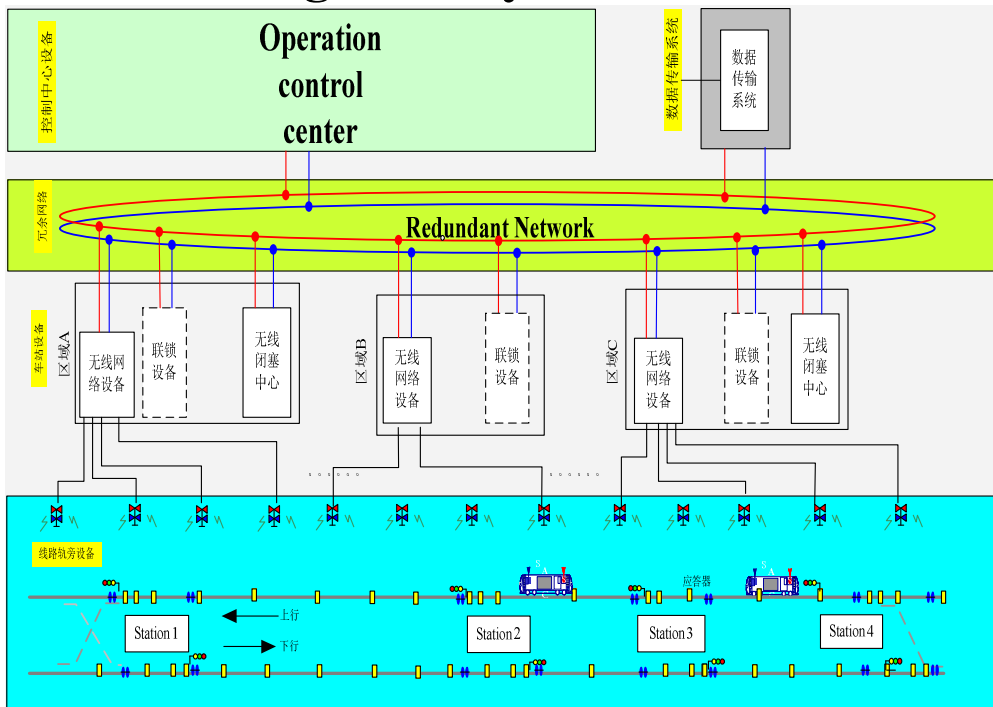
CBTC in Chinese Mass Transit

- **Communication Based Train Control (CBTC) is the direction of train control**
- **The advantages of CBTC are to increase safety and increase transport efficiency and improve the quality and reliability of information.**
- **CBTC is recently used in almost new lines of mass transit.**
- **The innovation research of CBTC has been done according to IEC safety standards since 2004.**



The new safety management system for CBTC Development

- CBTC is a complex safety system based on **computer, communication and control (3C) technology**.
- CBTC must have a good dependability. An new development method and safety management system is needed



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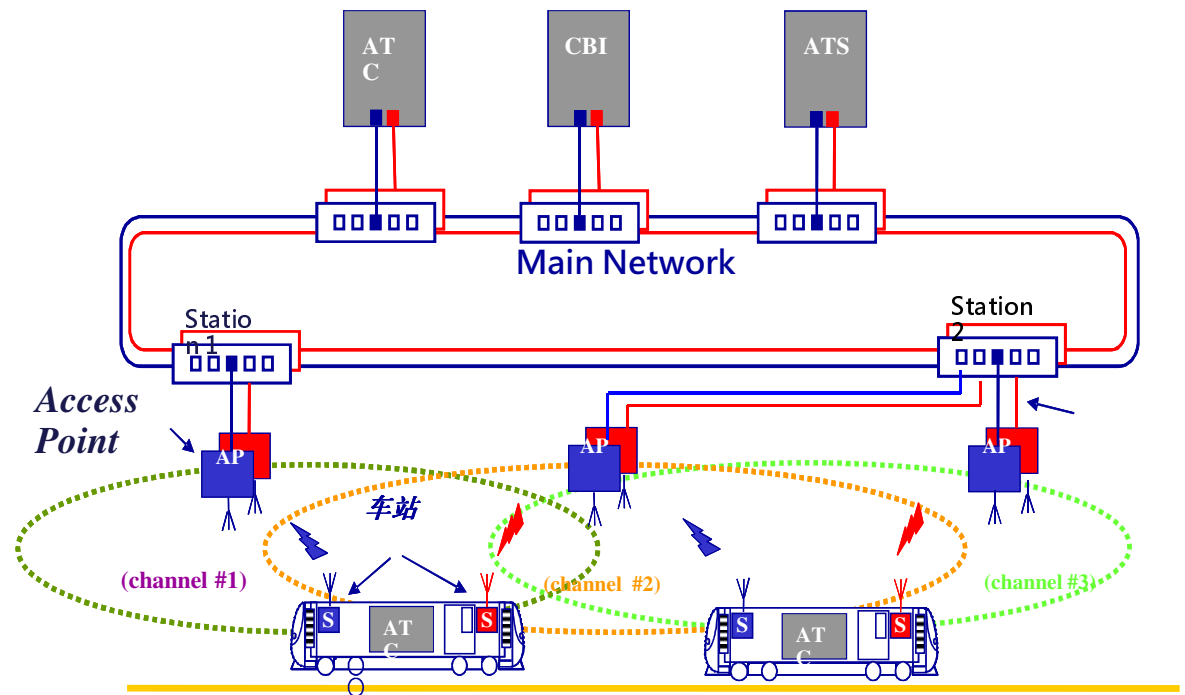
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The technology Innovation of CBTC system

We developed out:

- The key technology
- The system equipment of CBTC
- The two demonstration lines in Beijing, Yi zhuang Line and Chang Ping line **are going to be operated** in end of 2010



The main features of the CBTC

- The kind of train-to-ground transmission mode:

- Radio

- Leakage wave guide

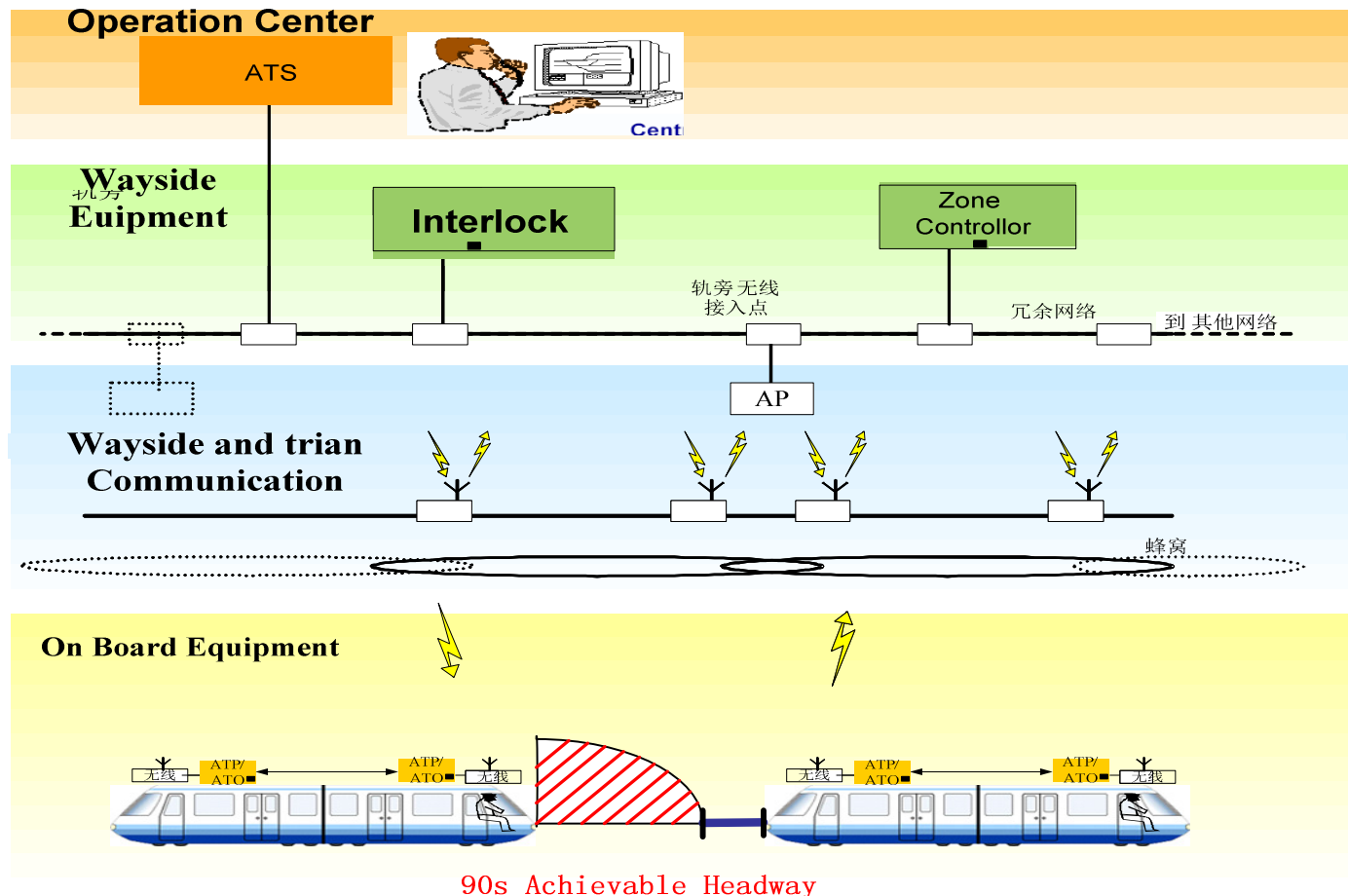
- Leakage cable

- Three level control mode

- Moving Block based on CBTC

- Fixed block based balise

- Interlock



Key Technology Of the CBTC

- Two Safety computer platform; 2 out of 3 for on board,- 2×2 out of 2 for wayside
- Model-based safety software design
- Automatic train operation
- System integration design and V&V Test



Integration Test Platform



**On-Board Equipment
of CBTC**



**Wayside Equipment
of CBTC**

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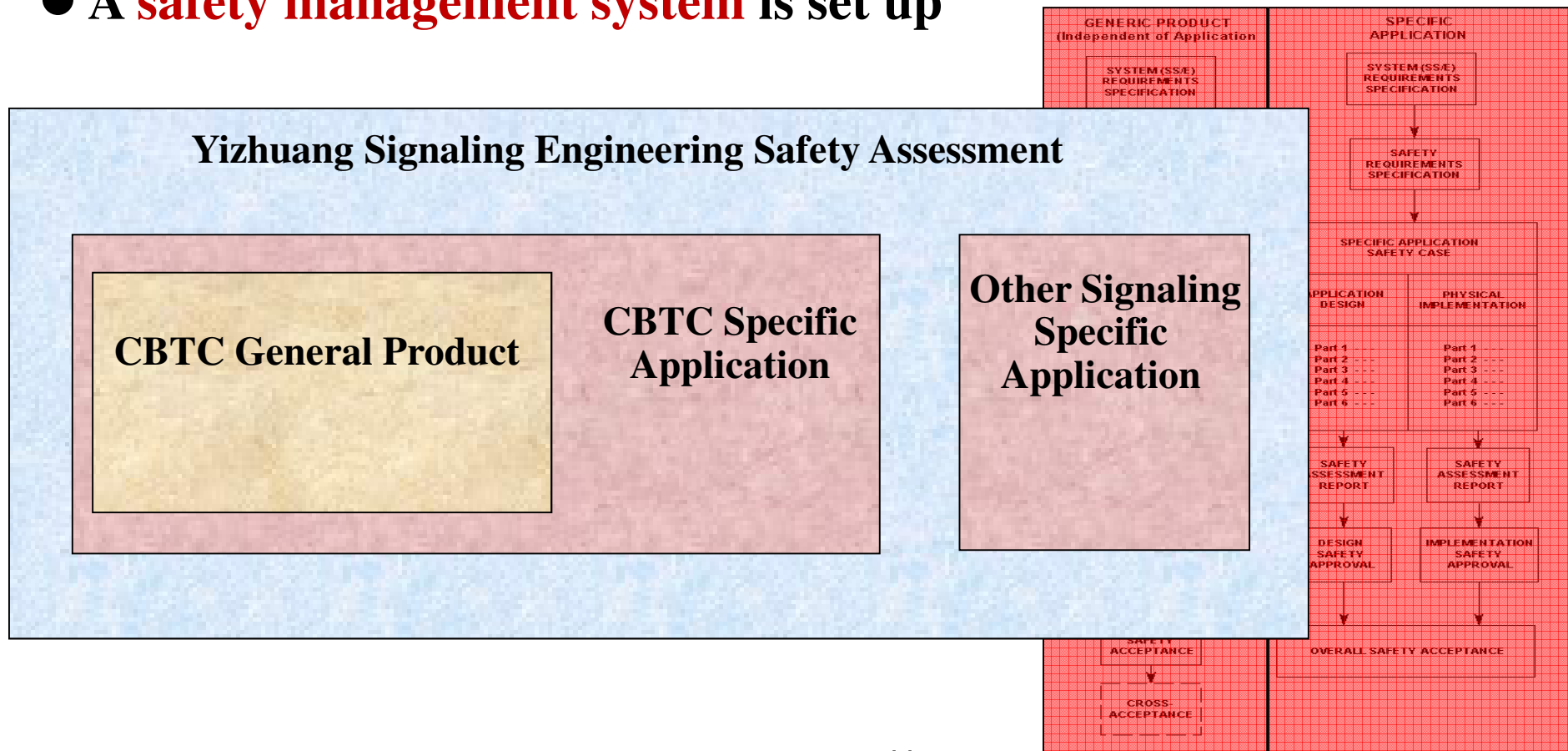
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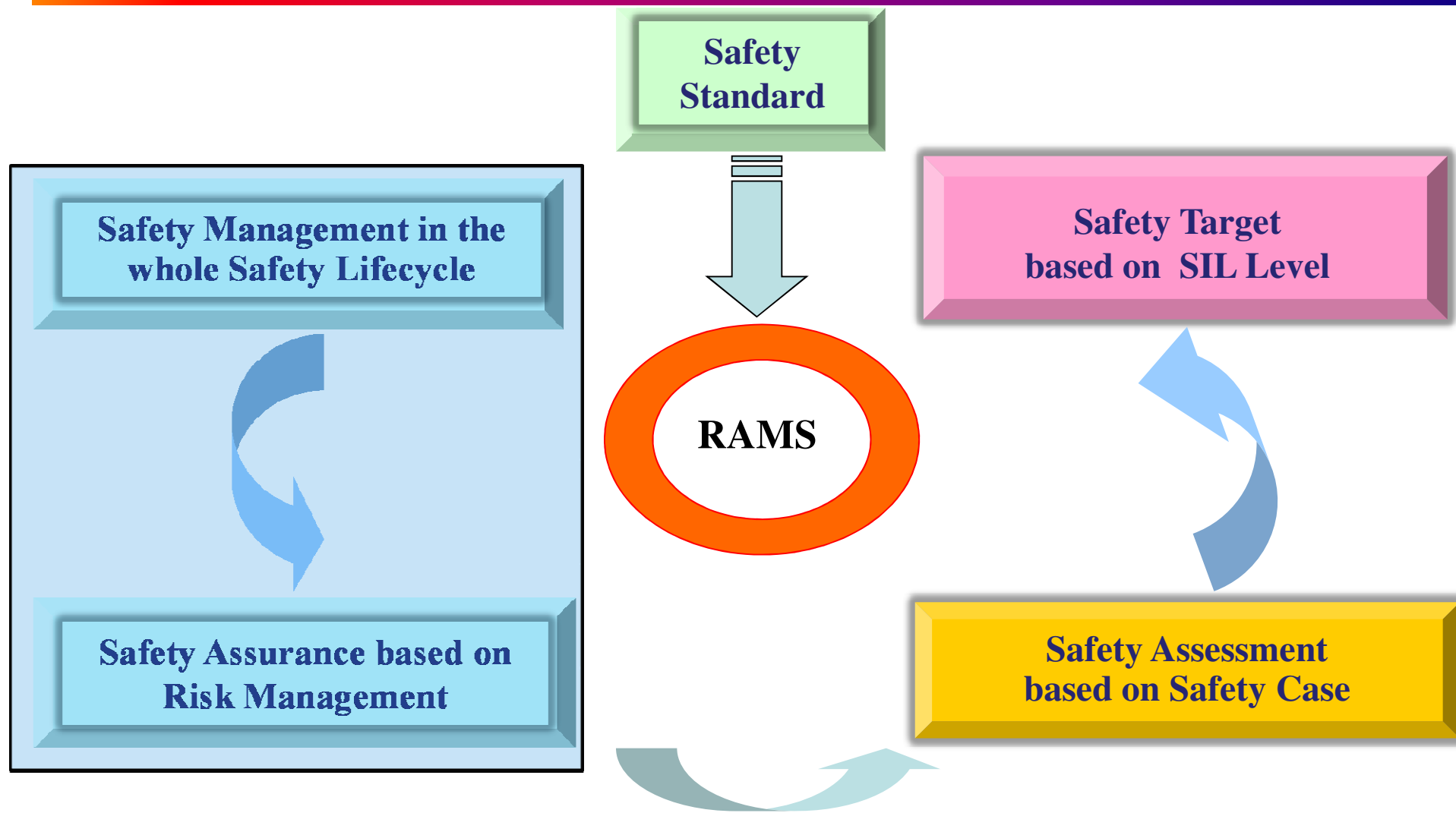
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General product Assessment & Specific Application Assessment of CBTC

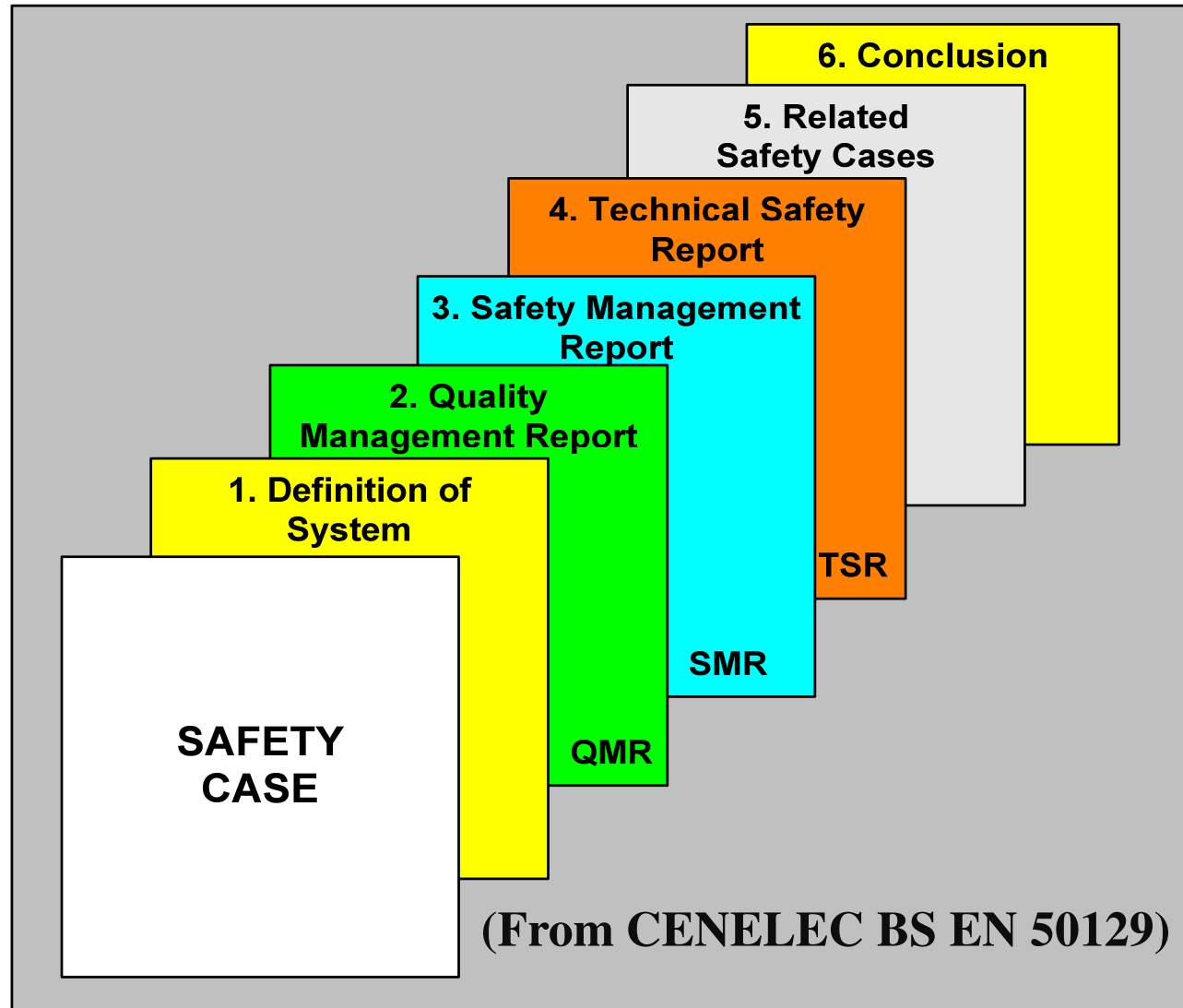
- The System is designed according to IEC safety standard;
- The general product Assessment of CBTC has been done
- The specific Application Assessment of CBTC is being done
- A **safety management system** is set up



The Main Points of Safety Assessment



Safety Management System

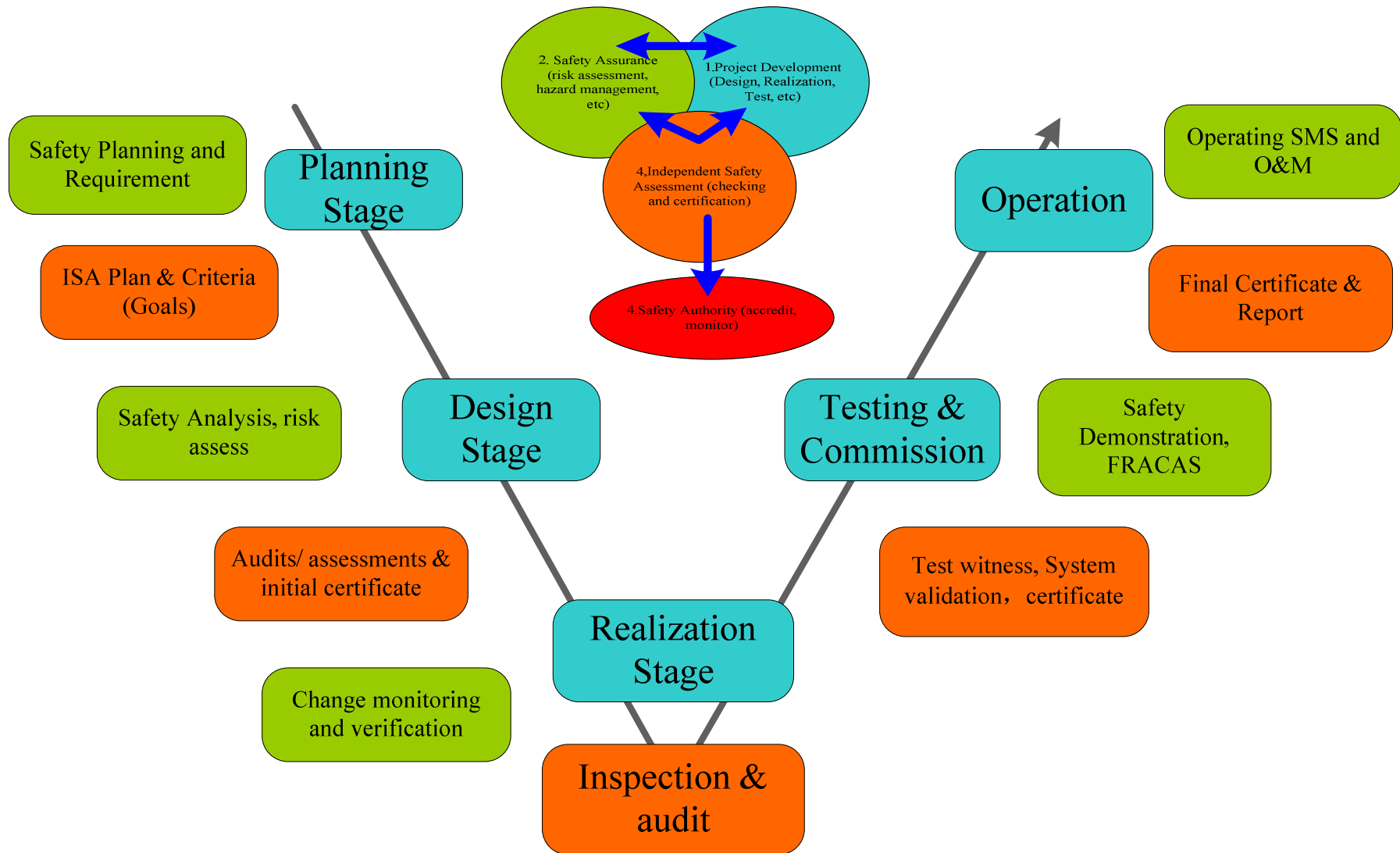


Safety Management System

➤ Safety management system should be built based on the established quality management system.

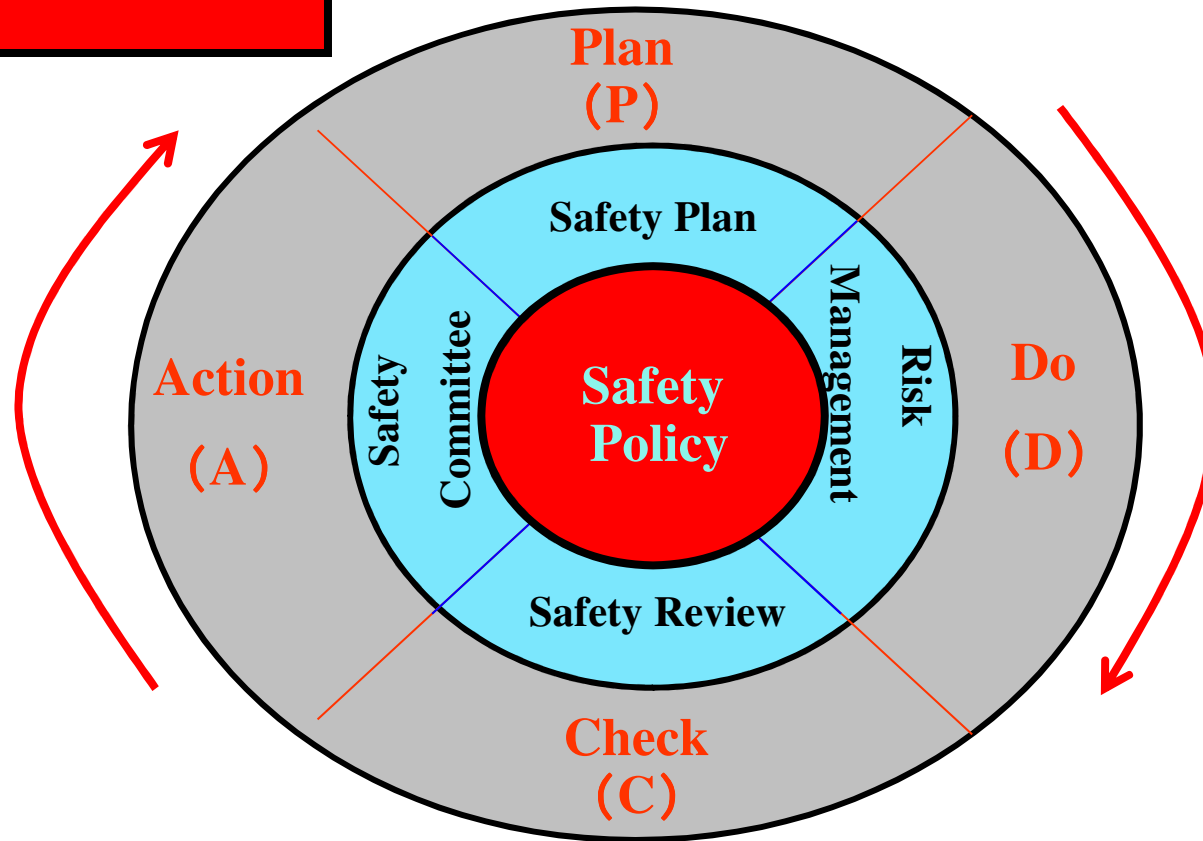


V&V Based Product Lifecycle of CBTC System



PDCA model for Safety Management System

**Safety Management
Best Practice**



Continual Improvement

The Whole Structure of Safety Management System

Organization

Relatively independent departments and effective check and supervision

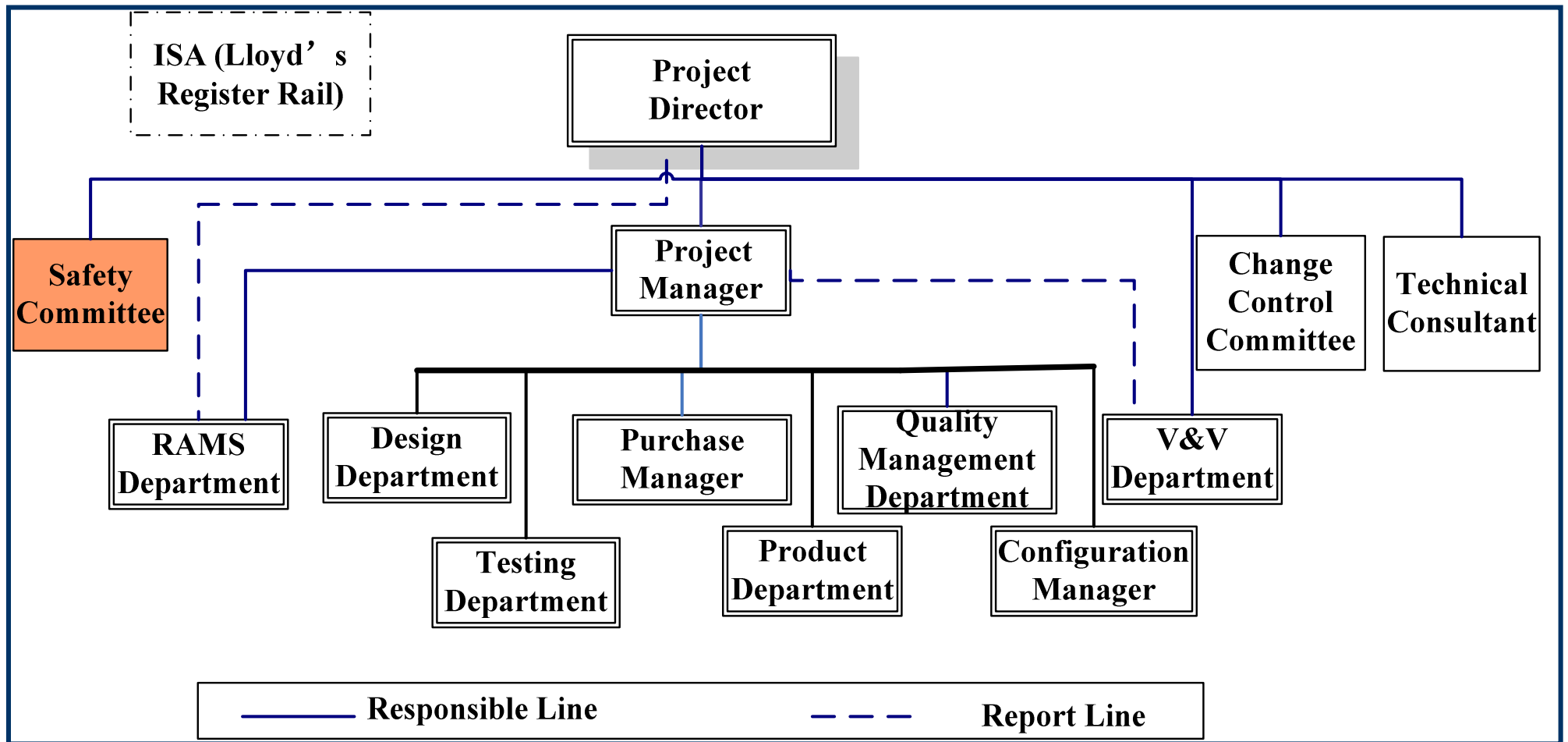
Procedure

Normalized procedures of development and safety assurance based on SOP

Platform

Platform based on Advanced Tools

Organizations





Procedure Management

Procedures

1	文件控制程序	9	采购过程控制程序
2	记录控制程序	10	产品交付控制程序
3	质量目标管理程序	11	售后服务控制程序
4	管理评审程序	12	内部审核控制程序
5	人力资源管理程序	13	产品的监视和测量程序
6	产品实现的策划程序	14	不合格品控制程序
7	产品要求的识别、评审和沟通程序	15	纠错控制程序
8	设计和开发控制程序	16	数据统计和预防措施控制程序

Instructions

1	产品生命周期流程规范
2	公司部门职责管理制度
3	研发测试流程
4	库房管理规定
5	设备管理制度
6	生成管理制度
7	标识及可追溯性管理规定
8	危险源管理流程
9	HAZOP程序

Tools Support

◆ Rational DOORS

- The **requirements management** tools to capture textural Requirements and optimize requirements communication, collaboration and verification chain.

◆ Teleological SYNERGY

- the **configuration management** tools

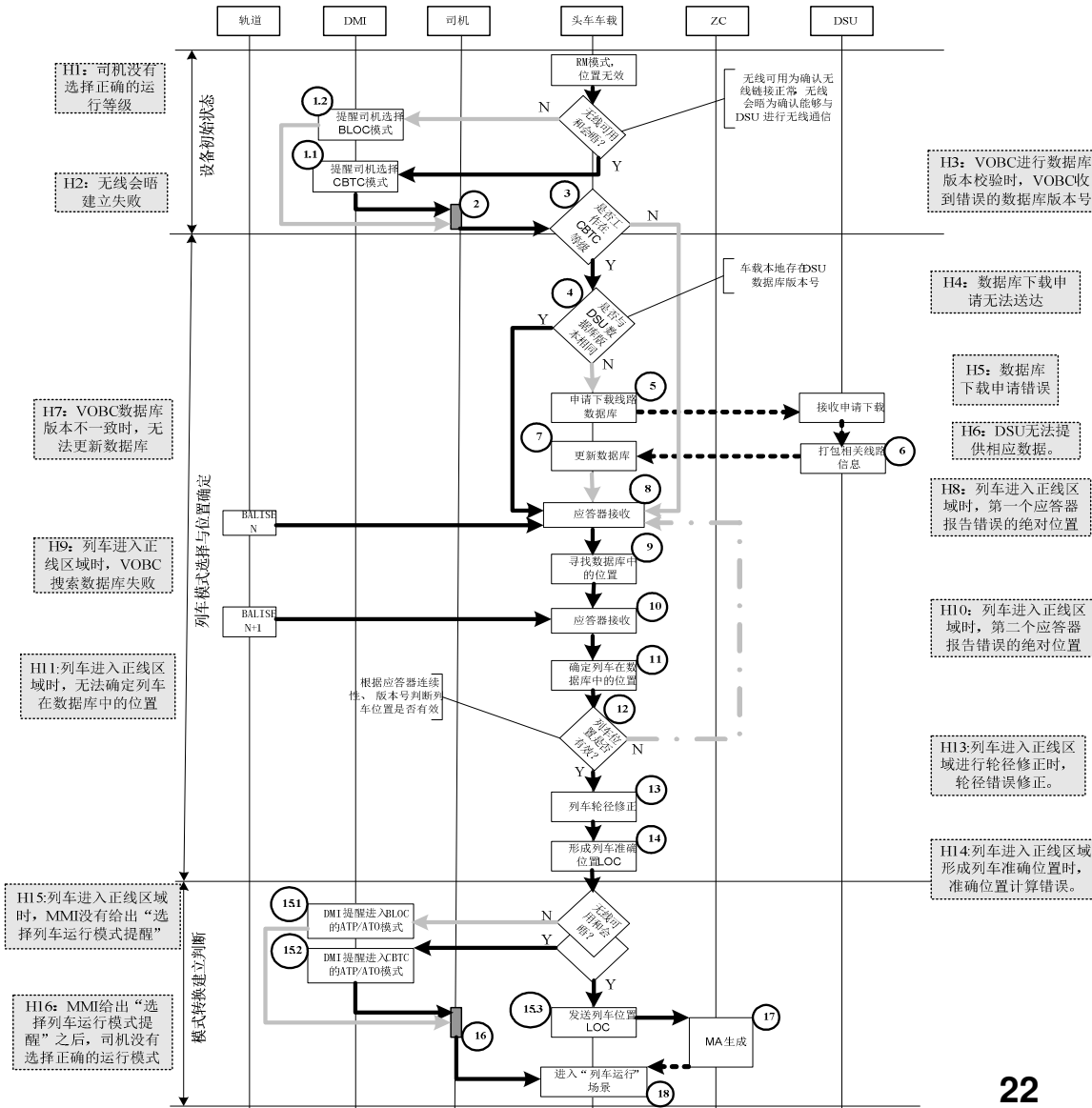
◆ CHANGE

- the **defect tracking** tools

Achievement of Risk Management

- ◆ **387 hazards are identified, including 135 critical hazards.**
- ◆ **172 safety requirements are determined, containing 15 requirements related to Operation and 157 requirements related to system design and testing.**

Hazard Identification using Scenario-guided HAZOP



1. Describe system by Operational Scenario Charts;

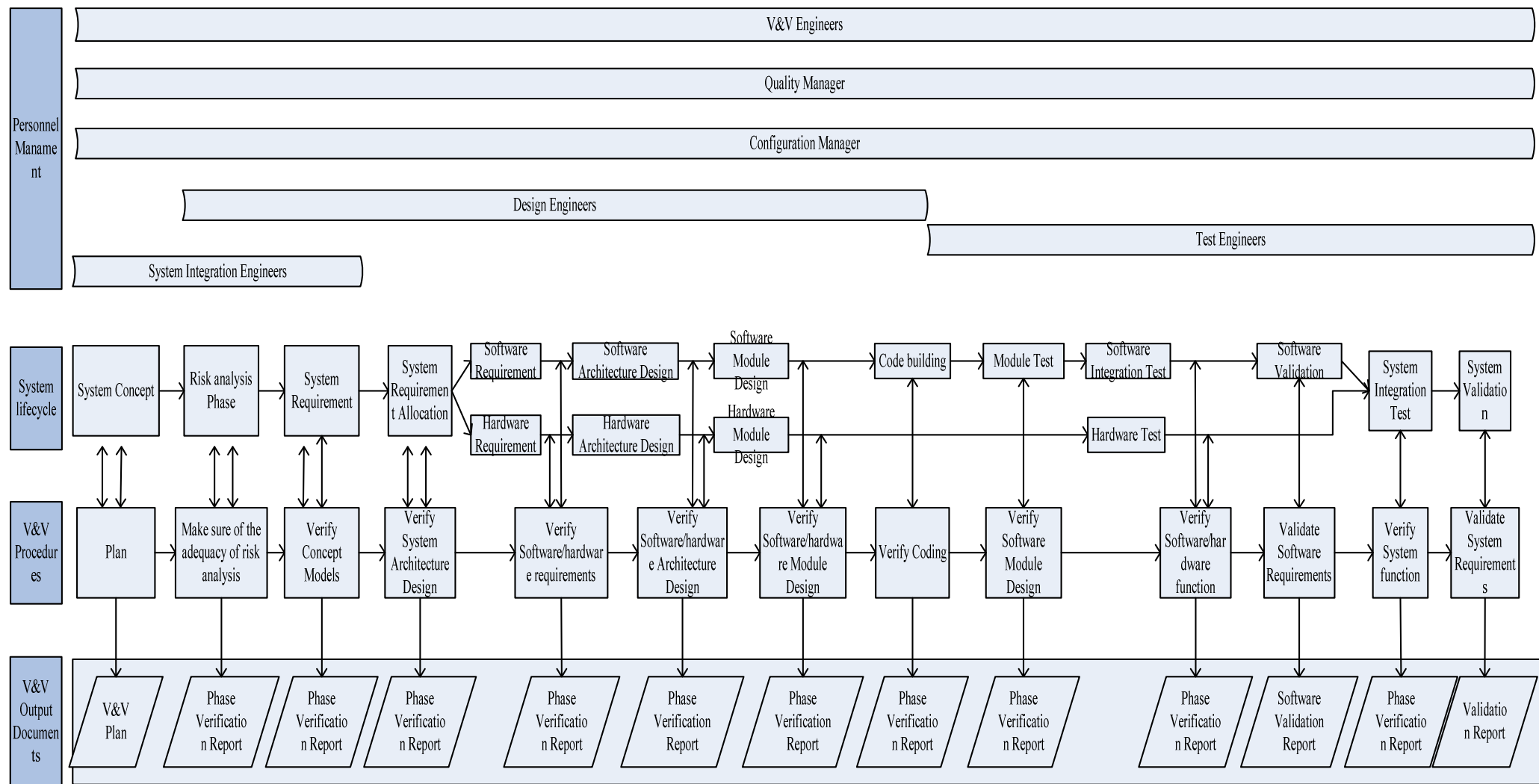
2. Use Guide Words (No, More, Less, etc) identify hazards in each flow.

3. Record analysis result and put them into Hazard Log.

Configuration File of CBTC Product (including more than 500 documents)

LCF-300列车控制系统文件配置单 LCF-300 Train Control System Document List (CBTC Product)					
项目名称: LCF-300列车控制系统产品研发;		项目编号: 0801-AA-CCA; 文件编号: LCF-300-索引号。			
Project Name: LCF-300 Train Control System Product Development;		Project ID: 0801-AA-CCA; Document ID: LCF-300-Number			
分类号	文件类别	索引号	文件名称	Document Name	备注 Notes
10	系统需求文件	1002	LCF-300型列车控制系统需求说明书	LCF-300 Train Control System Requirement Specification	RST-CBTC-CQ05 (Released)
		1003	场景图	Scenario Chart	
11	VOBC子系统需求文件	1101	VOBC子系统需求说明书	VOBC Subsystem Requirement Specification	Will be Released
		1102	车载ATP需求说明书	On-board ATP Requirement Specification	
		1104	车载MMI需求说明书	On-board MMI Requirement Specification	
		1105	车载测速定位设备需求说明书	On-board Speed Measurement and Position Determination Equipment Requirement Specification	
		1106	车载记录设备需求说明书	On-board Recording Equipment Requirement Specification	
		1108	车载110V转5V电源板硬件需求说明书	On-board 110V to 5V Power panel Hardware Requirement	
		1109	车载110V转24V电源板硬件需求说明书	On-board 110V to 24V Power panel Hardware Requirement	
		1110	车载ATP速度板硬件需求说明书	On-board ATP Speed Panel Hardware Requirement Specification	
		1111	车载ATP输入EMC板硬件需求说明书	On-board ATP Input EMC board Hardware Requirement Specification	
		1112	车载ATP输入板硬件需求说明书	On-board ATP Input board Hardware Requirement Specification	
		1113	车载ATP主机及通信板硬件需求说明书	On-board ATP Mainframe and Communication Board Hardware Requirement Specification	
		1114	车载MMI软件需求说明书	On-board MMI Software Requirement Specification	
		1115	车载ATP输出板硬件需求说明书	On-board ATP Output board Hardware Requirement Specification	
		1116	车载记录软件需求说明书	On-board Recording Software Requirement Specification	
		1117	车载ATP通信控制器(记录)板硬件需求说明书	On-board ATP Communication Controller(Recording) Board Hardware Requirement Specification	
		1118	车载ATP母板硬件需求说明书	On-board ATP Main board Hardware Requirement Specification	
		1119	车载ATP应用软件需求说明书	On-board ATP Application Software Requirement Specification	Will be Released
		1120	车载ATP3取2平台软件需求说明书	On-board ATP 3-out of-2 platform Software Requirement Specification	
		1121	车载ATP通信板软件需求说明书	On-board ATP Communication Board Software Requirement Specification	
		1122	车载ATP通信控制器软件需求说明书	On-board ATP Communication Controller Software Requirement Specification	
		1123	车载MMI硬件需求说明书	On-board MMI Hardware Requirement Specification	
		1124	车载ATP公共板硬件需求说明书	On-board ATP Common Board Hardware Requirement Specification	
		1130	车载ATP输出继电器板硬件需求说明书	On-board ATP Output Relay Board Hardware Requirement Specification	
12	ZC子系统需求文件	1201	ZC子系统需求说明书	ZC Subsystem Requirement Specification	
		1202	安全计算机平台需求说明书	Safety Computer Platform Requirement Specification	Will be Released
		1203	ZC应用软件需求说明书	ZC Application Requirement Specification	
		1204	ZC维护软件说明书	ZC Maintenance Software Requirement Specification	
		1205	安全计算机平台电源板需求说明书	Safety Computer Platform Power Panel Requirement Specification	
		1206	安全计算机平台输入输出板需求说明书	Safety Computer Platform Input-Output Board Requirement Specification	
		1207	安全计算机平台通信板需求说明书	Safety Computer Platform Communication Board Requirement Specification	
		1208	安全计算机平台逻辑板电路需求说明书	Safety Computer Platform Logic Board Circuit Requirement Specification	
		1209	安全计算机平台逻辑板FPGA设计需求说明书	Safety Computer Platform Logic Board FPGA design Requirement Specification	
		1210	主机平台软件需求说明书	Mainframe Platform Software Requirement Specification	

V&V Activities and Reports in the System Lifecycle



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Safety Assessment System for China Railway

(1) To establish a SMS framework in China railway

- ◆ A rectification of strategy will essentially improve an internal circumstance for China railway safety management.
- ◆ Establishing testing specification standard and independent testing platform
- ◆ Educating system safety engineers, and introducing system safety assurance methods based on risk analysis.

**Qualified “athlete” team
and “judge” system.**

Safety Assessment System for China Railway

(2) Setting up an Independent Testing Mechanism

- ◆ To proof all safety targets are achieved
- ◆ Independent Testing Mechanism should be established considering policy and humanism condition:
 - In-door testing by independent testing lab
 - Site-testing by independent organization





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Thank you



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