CCUS集成项目全生命周期风险管理与监管框架
Regulation and risk management for Integrated CCS Projects

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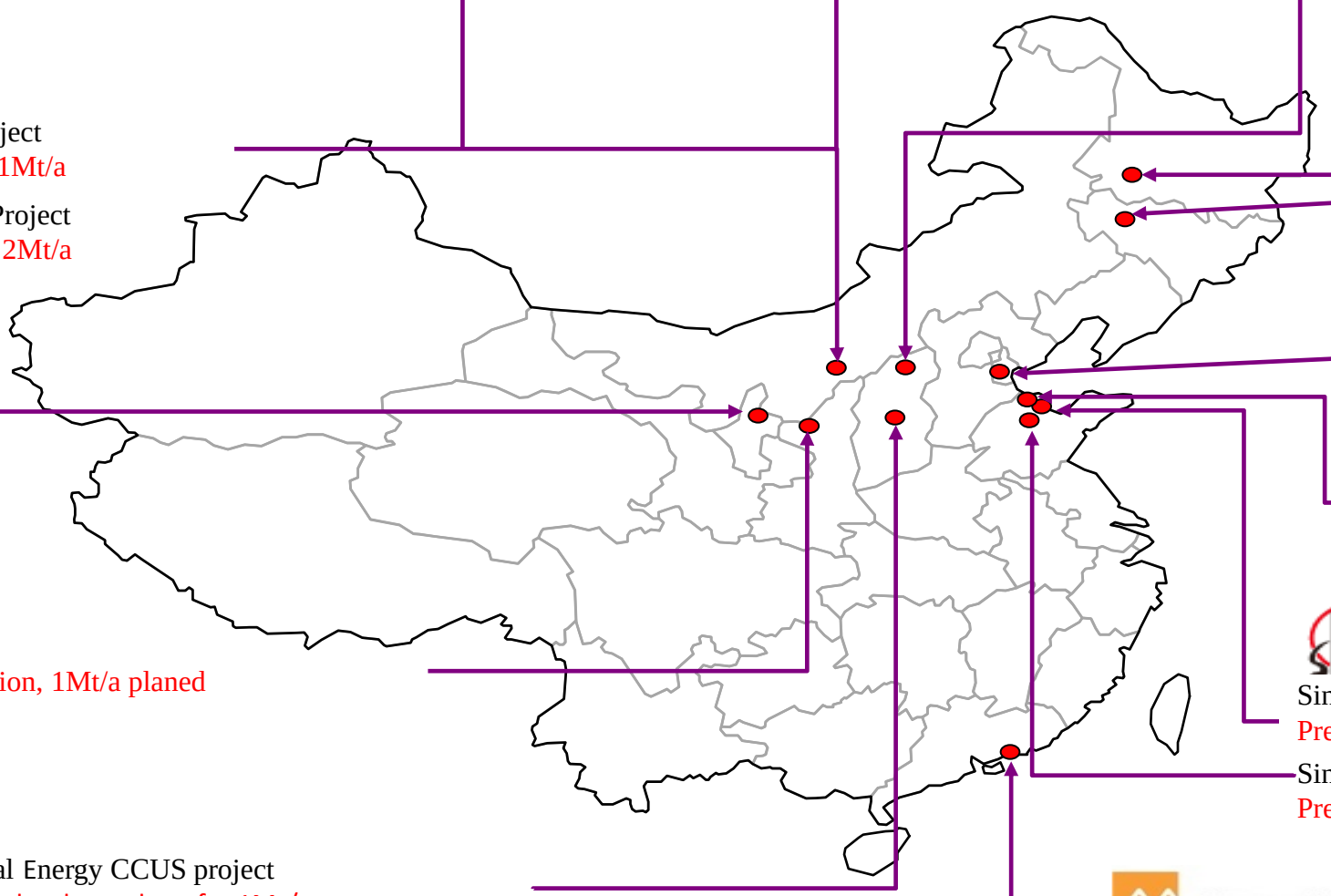
Lots of announced LS projects



CNOOC Datong coal gasification project
Pre-feasibility for 1Mt/a

CPI-TOTAL CTO Project
Pre-feasibility study for 1Mt/a

CNOOC Ordos coal gasification project
Pre-feasibility for 1Mt/a

China Datang Co. CCS project
Pre-feasibility for 1Mt/a

Shenhua Ordos CTL Project
Pre-feasibility study for 1Mt/a

PetroChina Jilin Oilfield EOR Project
500kt/a planed, but short of CO_2

Shenhua Ningxia CTL Project
Pre-feasibility study for 2Mt/a

Huaneng Tianjin IGCC Project
Pre-feasibility study 2Mt/a

China Datang Co. EOR project
Pre-feasibility for 1Mt/a

Yanchang EOR Project
400kt/a under construction, 1Mt/a planed

Sinopec Shengli Power Plant EOR Project
Pre-feasibility study for 1Mt/a

Sinopec Qilu Petrochemical EOR Project
Pre-feasibility study for 1Mt/a

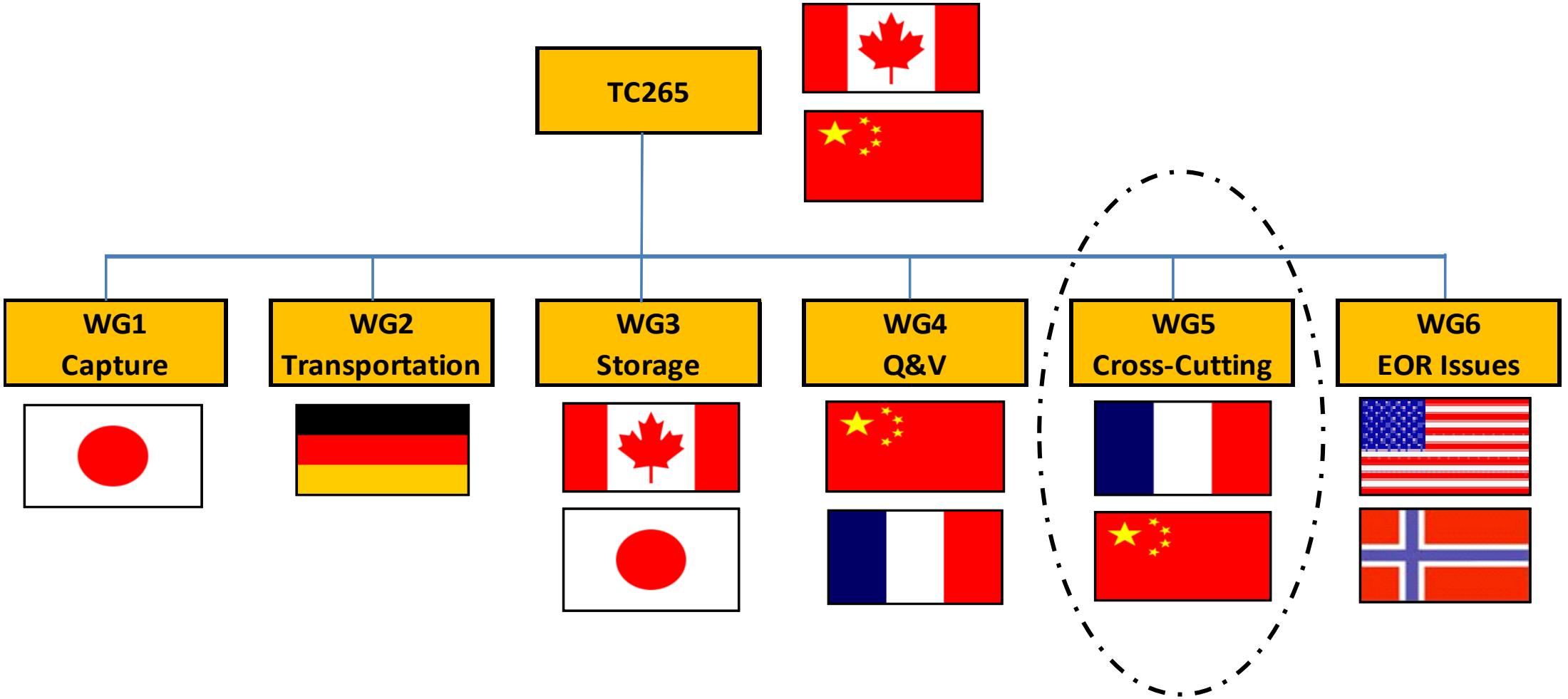
Shanxi International Energy CCUS project
Pre-feasibility study has been done for 1Mt/a

CR Power(Haifeng) CCS Project
Jnder pre-feasibility study for 1Mt/a

Outline

- **集成项目风险管理 Risk management**
  - 输送与封存环节的风险 Risks in transport and storage
  - 集成项目风险 Risks in Integrated CCS projects
- **监管框架 regulation**
  - 类似项目的监管 Similar projects
  - CCUS项目监管 CCUS projects
- **策略建议 Suggestions**

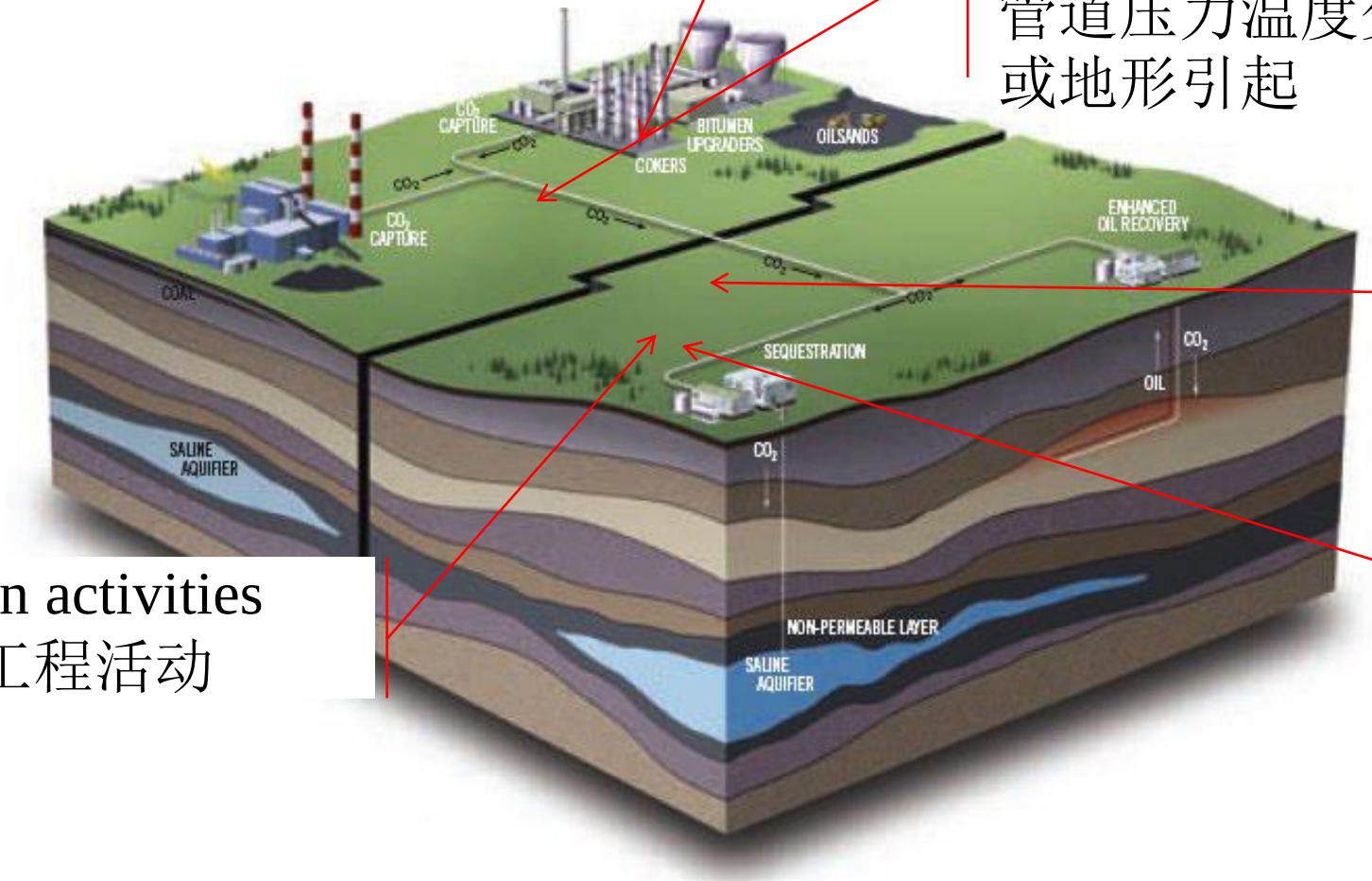
TC265架构 TC265 Structure



Component risks-pipeline 管道风险

Change of CO_2 stream composition
CO_2流组分变化：新源的接入等

Pressure and temperature change in the pipeline：
Caused by operation (Vent，shut-in and depressurization) or topography etc.
管道压力温度变化：操作（排放、关停、减压）或地形引起



Internal corrosion and erosion
内部腐蚀和侵蚀

External natural impacts
外部自然影响（地质灾害/气象灾害等）

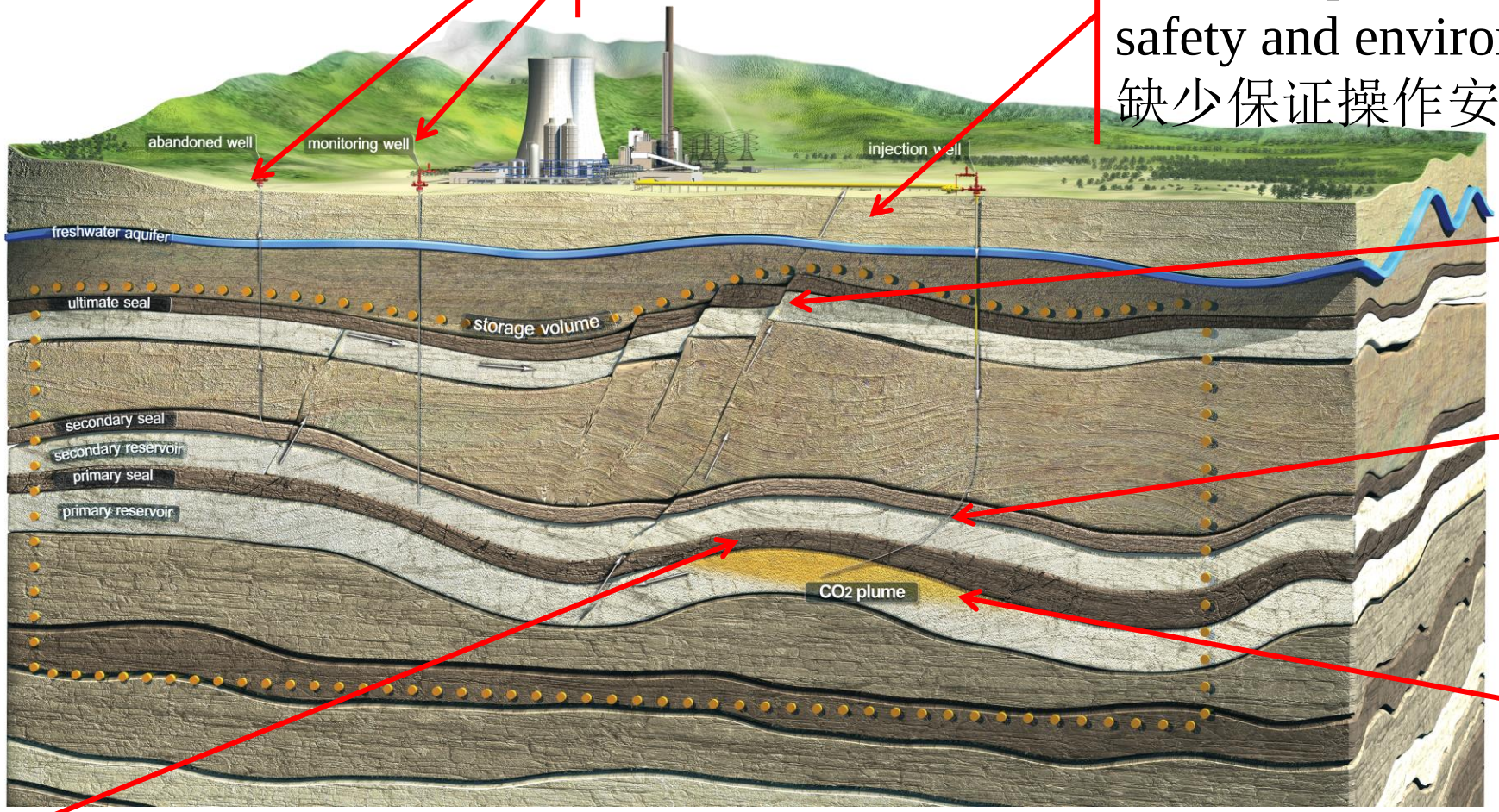
Human activities
人类工程活动

Component risks-storage 封存风险

Abandoned well undetected or cannot meet the requirements
废弃井未被发现或达不到要求

Cost-effective monitoring unavailable
监测措施无效或者不可行

Lack of operational procedures to ensure safety and environmental protection
缺少保证操作安全和环境保护的规程



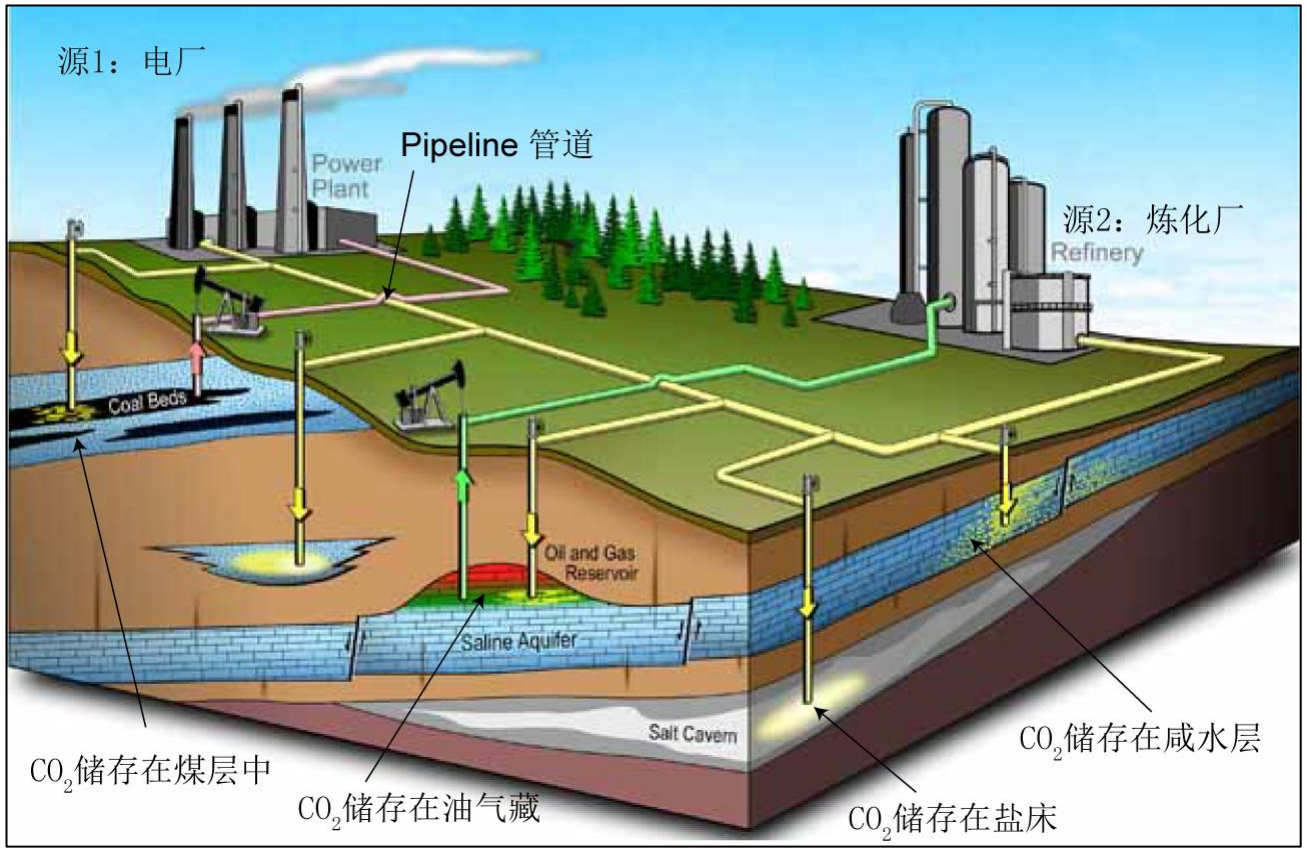
Seismicity or earth deformation over acceptable levels
诱发地震或地表变形

Insufficient injectivity
注入性不足

Insufficient capacity
容量不足

Can’t provide long-term containment不能提供长期封闭性能

Lifecycle risk management for integrated CCS projects (CCS集成项目全生命周期风险管理）

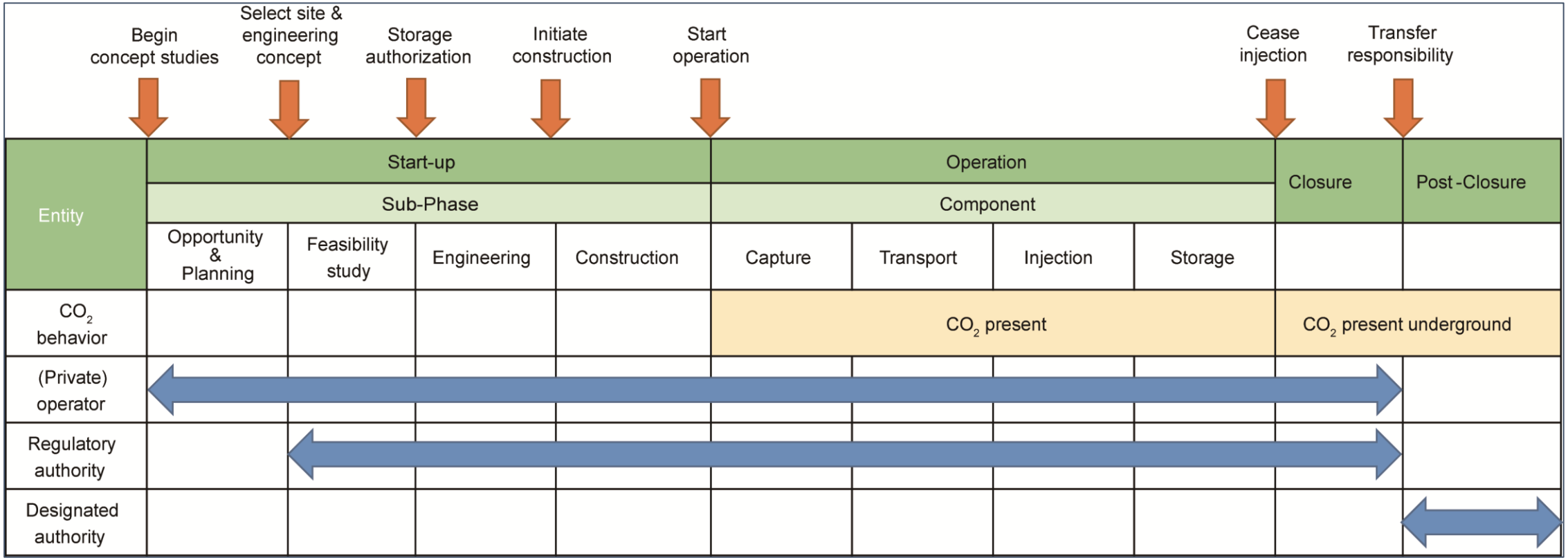


- Integrated CCS projects: Projects involve the capture, transport and storage of CO_2.

  CCS集成项目：包含有CO_2捕集、运输和封存环节

– Single source-sink CCS projects 单源汇CCS项目
– Extensive CCS infrastructures 大量的CCS设施

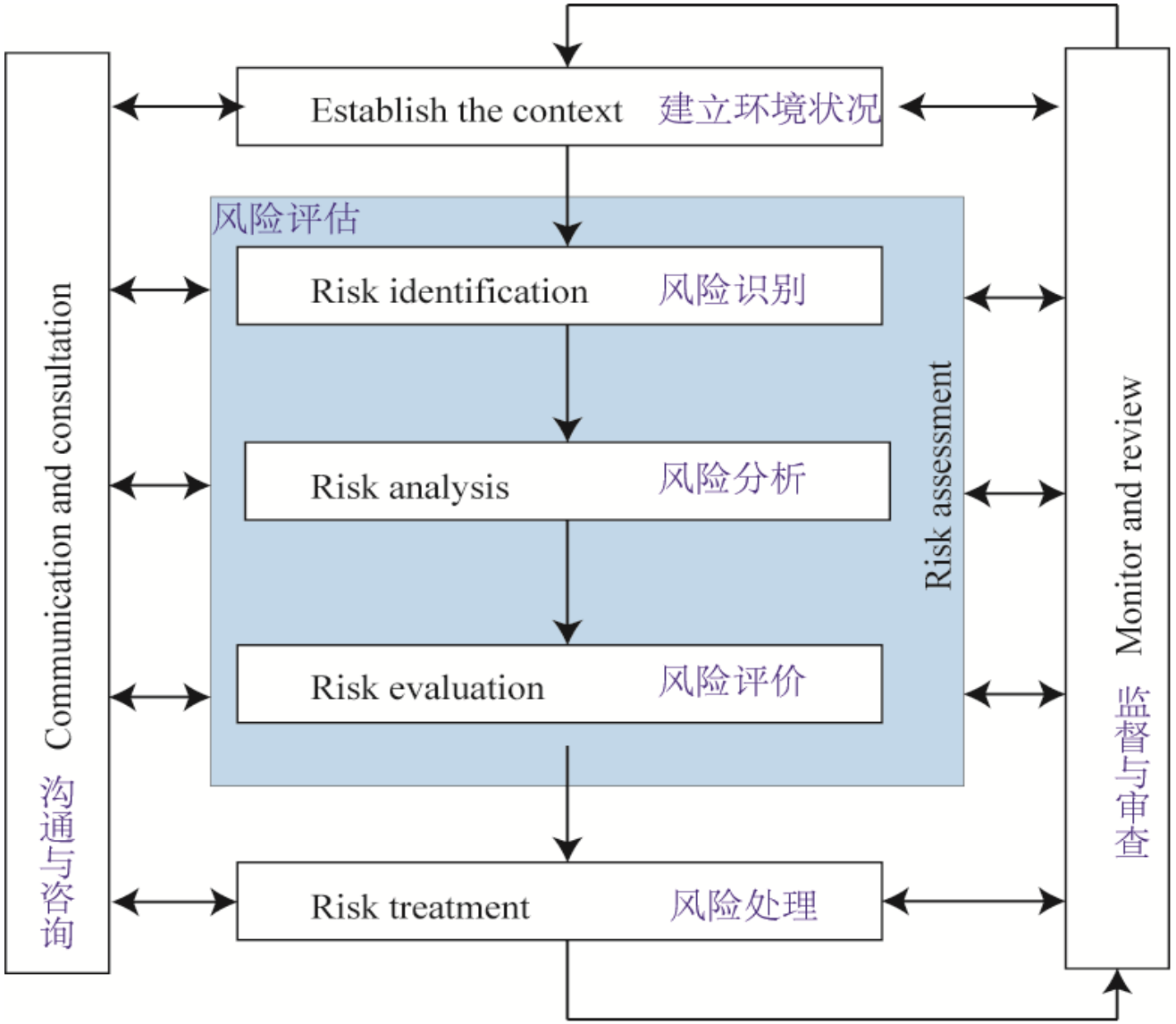
Lifecycle risk management for integrated CCS projects (CCS集成项目全生命周期风险管理）



Facilitate decision-making, distinguish liability, and describe the timing of risk occurrence

Lifecycle risk management for integrated CCS projects (CCS集成项目全生命周期风险管理）

风险管理？



ISO:31000

Identification of overarching and cross-cutting risks识别全局风险和交叉风险

- **Overarching, or overall risks** are risks that affect the entire CCS project.

  全局风险是影响整个CCS项目的风险。

- **Cross-cutting risks** are risks that affect more than one part of a CCS project chain. Integration risks are considered cross-cutting for the purposes of this report.

  交叉风险是影响CCS项目一个以上环节的风险。

Overarching risks 全局风险（15）

OA – 全局or XC-交叉	Policy, Economic, or Technical,	Risk	whole project (W), or Capture, Transport, or Storage	Start-up				Operation			Closure	Post- Closure
				Opportunity	Planning	Engineering	Construction	Capture	Transport	Injection		
OA	Policy	Legal Uncertainties (including pore space ownership)法律的不确定性，包括孔隙空间所有权	W	X	X	X	X	X	X	X	X	X
OA	Policy	Uncertain cost or regulations for integrated project, e.g. plugging and abandonment (closure/post closure)成本和法规的不确定性，例如封堵和废弃（闭场、闭场后）	W								X	
OA	Policy	Public engagement (public opposition, risk communication, public disclosure of data, etc.)公众参与（公众的反对、风险沟通、数据的公开披露等）	W	X	X	X	X	X	X	X		
OA	Policy	Project permits not obtained未获得项目许可	W	X	X							
OA	Economic	Lack of financial driver e.g., CO_2 price/credit, benefit (oil or other products)缺乏财政驱动力，例如CO_2价格、额度和收益（油或其它产品）	W			X	X	X	X	X		
OA	Economic	Insufficient project financial resources-cost of capital项目财源不足，如融资成本	W	X	X							
OA	Economic	Unexpected construction or operational cost changes预期外的建设或操作成本变化（价格变化等）	W			X	X	X	X	X	X	
OA	Economic	Uncertainty in CO_2 supply CO_2供应的不确定性	W					X	X	X		
OA	Economic, Policy	Lack of emission accounting碳排放核算的缺失	W			X	X	X	X	X		

Overarching risks 全局风险

OA-全局 Or XC-交叉	Policy, Economic, or Technical,	Risk	whole project (W), or Capture, Transportation, or Storage	Start-up				Operation			Closure	Post- Closure
				Opportunity	Planning	Engineering	Construction	Capture	Transportation	Injection		
OA	Technical	Technology scale-up技术放大（条件、进步）	W			X	X	X	X	X		
OA	Technical	Lack of knowledge/qualified resources for operating the unit缺乏操作知识和合格资源	W	X	X	X	X	X	X	X		X
OA	Technical	Project impacts on environment项目对环境的影响	W				X	X	X	X	X	X
OA	Technical	External natural impacts on project外部自然过程对项目的影响	W					X	X	X	X	X
OA	Technical	External man-made impacts on project外部人为活动对项目的影响	W					X	X	X	X	X
OA	Technical	Site uncertainty-planning, conflict with other usage, rights场址的不确定：规划、与其他使用及权利的冲突	W				X	X	X	X		

Cross-cutting risks 交叉风险（13）

OA-全局 Or XC-交叉	Policy, Economic, or Technical,	Risk	whole project (W), or Capture, Transportation, or Storage	Start-up				Operation			Closure	Post- Closure
				Opportunity	Planning	Engineering	Construction	Capture	Transportation	Injection		
XC	Technical	Accidental or intentional interruption or intermittency of CO_2 supply, CO_2 in-take or transportation意外、故意中断或**间歇性**的CO_2供应、进入或运输	C⇆T⇄S					X	X	X		
OA XC	or Technical	Shared infrastructure by multiple projects (uncertain ownership, performance or lack of coordination)多个项目**共用设施**（不确定的所有权、性能或缺乏协调）	C⇆T⇄S					X	X	X		
OA XC	or Technical	Using existing facilities (especially pipeline, knowledge on condition, obligation to other user, CO_2 or material specifications, uncertain timing)使用**已有的设施**（特别是管道：条件认知、对其他用户的义务、CO_2或材料规格、不确定的时间）	C⇆T⇄S		X	X	X		X	X		
XC	Technical	Unintended phase change意想不到的**相变**	C⇆T⇄S							X		
XC	Technical	CO_2 out of specifications: source gas composition is not as expected CO_2不符合**规格**：气体不符合预期	C→T→S					X				

Cross-cutting risks 交叉风险

OA – 全局 or XC- 交叉	Policy, Economic, or Technical,	Risk	whole project (W), or Capture, Transportation, or Storage	Start-up				Operation			Closure	Post- Closure
				Opportunity	Planning	Engineering	Construction	Capture	Transportation	Injection		
XC	Technical	Mismatched component performance (capacity, resource, flexibility, efficiency well integrity or lifetime)环节不匹配（能力、资源、灵活性、效率、井的完整性、使用寿命）	C⇆T⇄S					X	X	X		
XC	Technical	Lower capture efficiency due to the upstream plant flexible operation上游排放源运行变动导致的捕集效率低	C→T→S					X				
XC	Technical	Insufficient storage resource封存资源不足	S→T→C							X		
XC	Technical	Reservoir does not perform as predicted (injectivity reduction, storage resource, geomechanical stability, containment)储层性能不如预期（注入性下降、地质稳定性、封闭性）	S→T→C							X	X	X
XC	Technical	Model uncertainties regarding the storage performance (capacity/injectivity/containment) 储层性能模型的不确定性（能力、注入性、封闭性）	S→T→C	X	X	X	X			X		X
XC	Technical	Lack of Maintenance and emergency control procedures/ Safety related accident维护和应急控制程序、事故相关安保的不足	C⇆T⇄S					X	X	X		
XC	Technical	Corrosion and material problems腐蚀和材料问题	C⇆T⇄S					X	X	X		
OA or XC	All	Transportation Risks输送风险	T→S→C						X			

Address risks 风险应对

- Use a team with a range of experience and diverse expertise which covers whole CCS subsystems涵盖整个CCS子系统经验丰富的**专家团队**
- Consider all information that relates to risk targets, sources, and pathways: historical data, theoretical analysis, informed opinions, expert advice, and stakeholder input.考虑与风险目标、源和路径有关的**所有信息**：历史数据、理论分析、专家意见和利益相关者的**观点**
- Apply available and practical techniques for risk identification. 运用实用的方法**识别风险**。以上清单可作为工作的起点。
- Conduct a systematic approach in sufficient detail to comply with the established objectives and scope of the risk analysis.采用系统方法进行分析评估。

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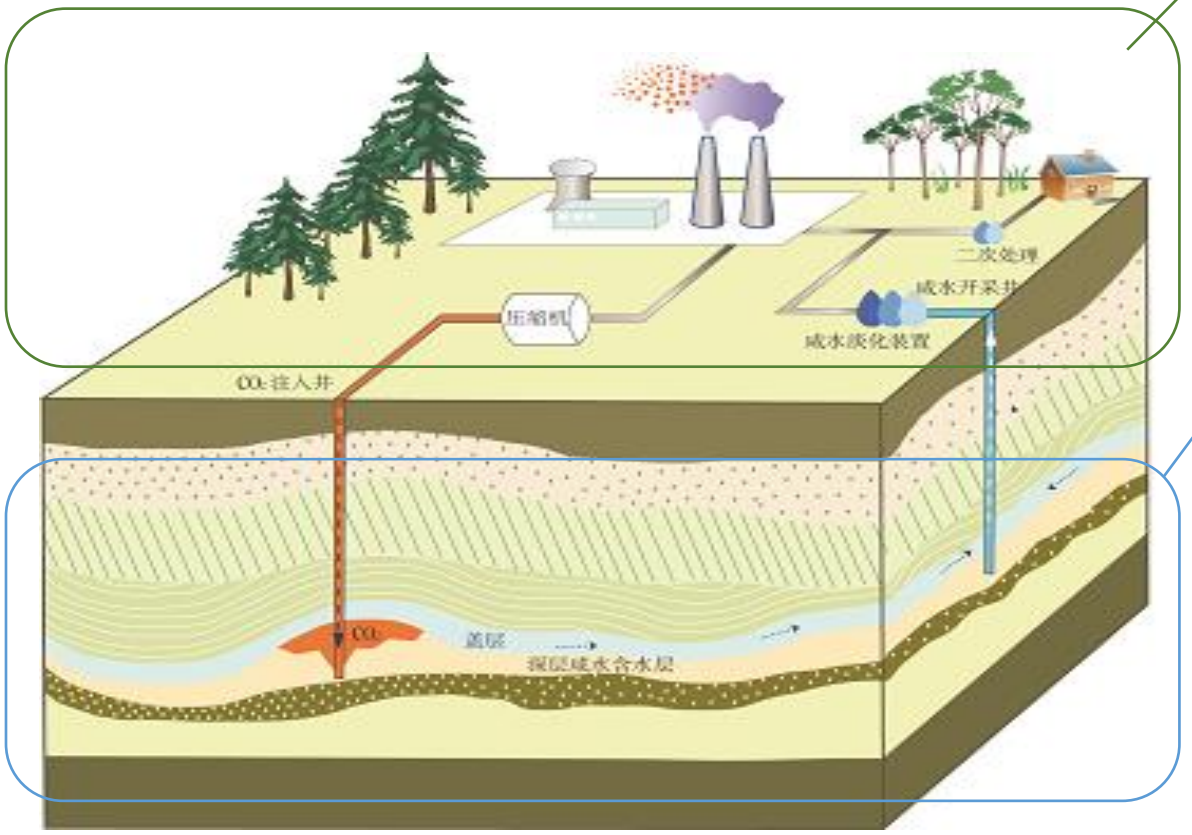
Approaches



Similar to the chemical industry
类似化工行业

Similar to the mining industry
类似采矿行业

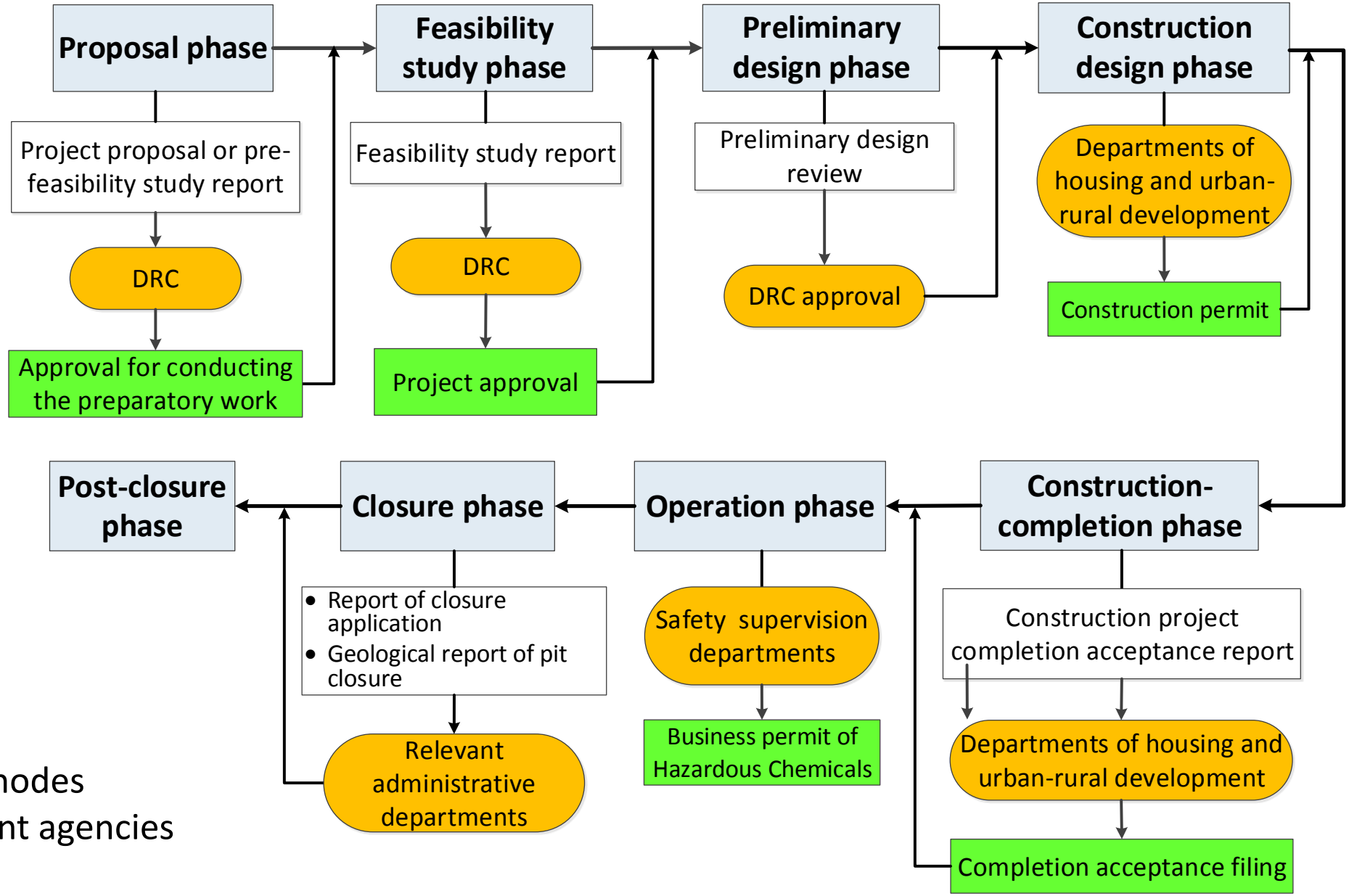
Regulatory system of construction projects
建设工程监管体系

+

CCS features
CCS特点

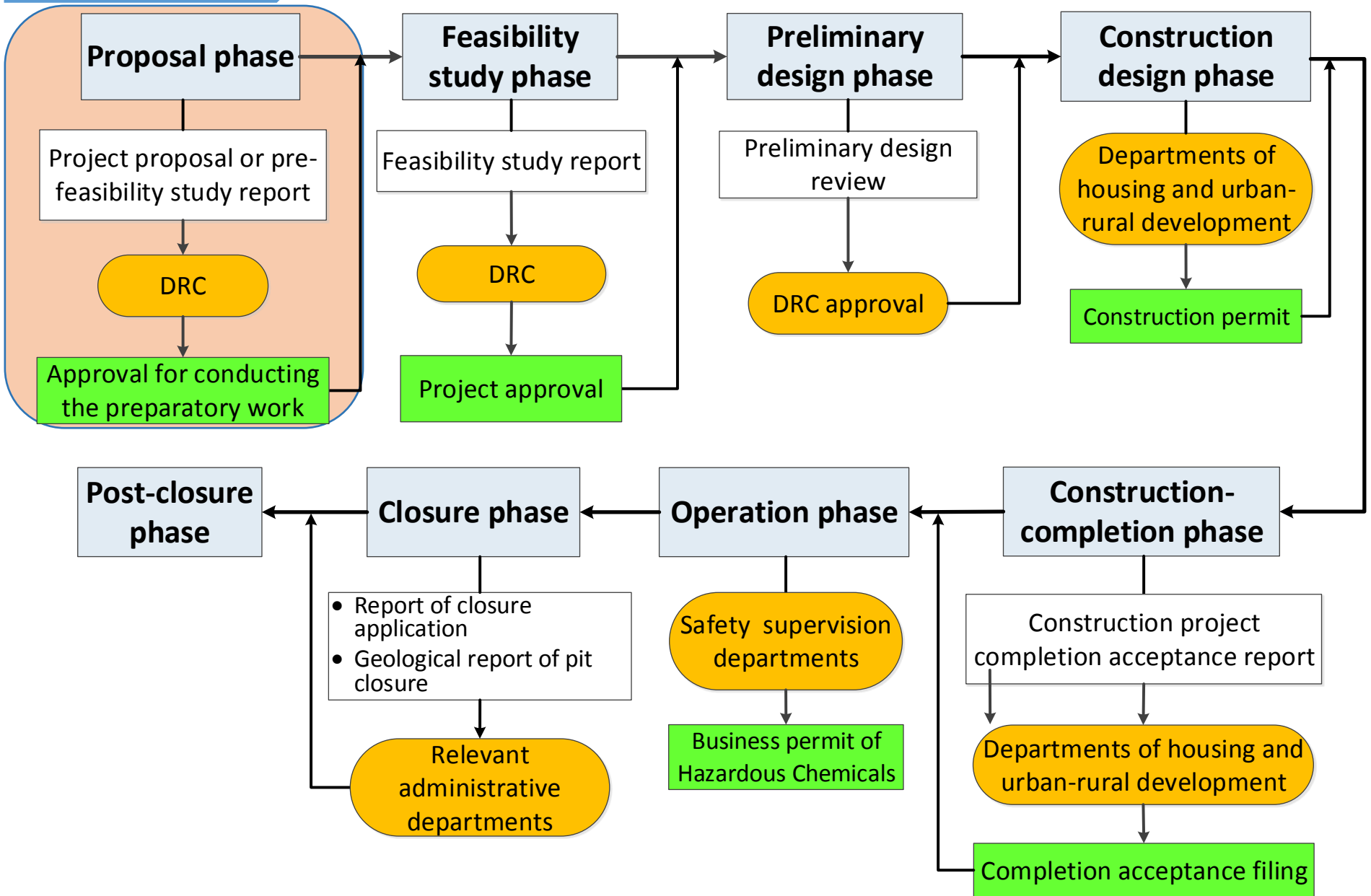
Recommendations for regulating the CCS demos
CCS示范工程监管建议

Regulatory system for construction projects



- 8 phases
- 6 regulatory nodes
- 13 government agencies

Regulatory system for construction projects



Regulatory system for construction projects

Proposal phase

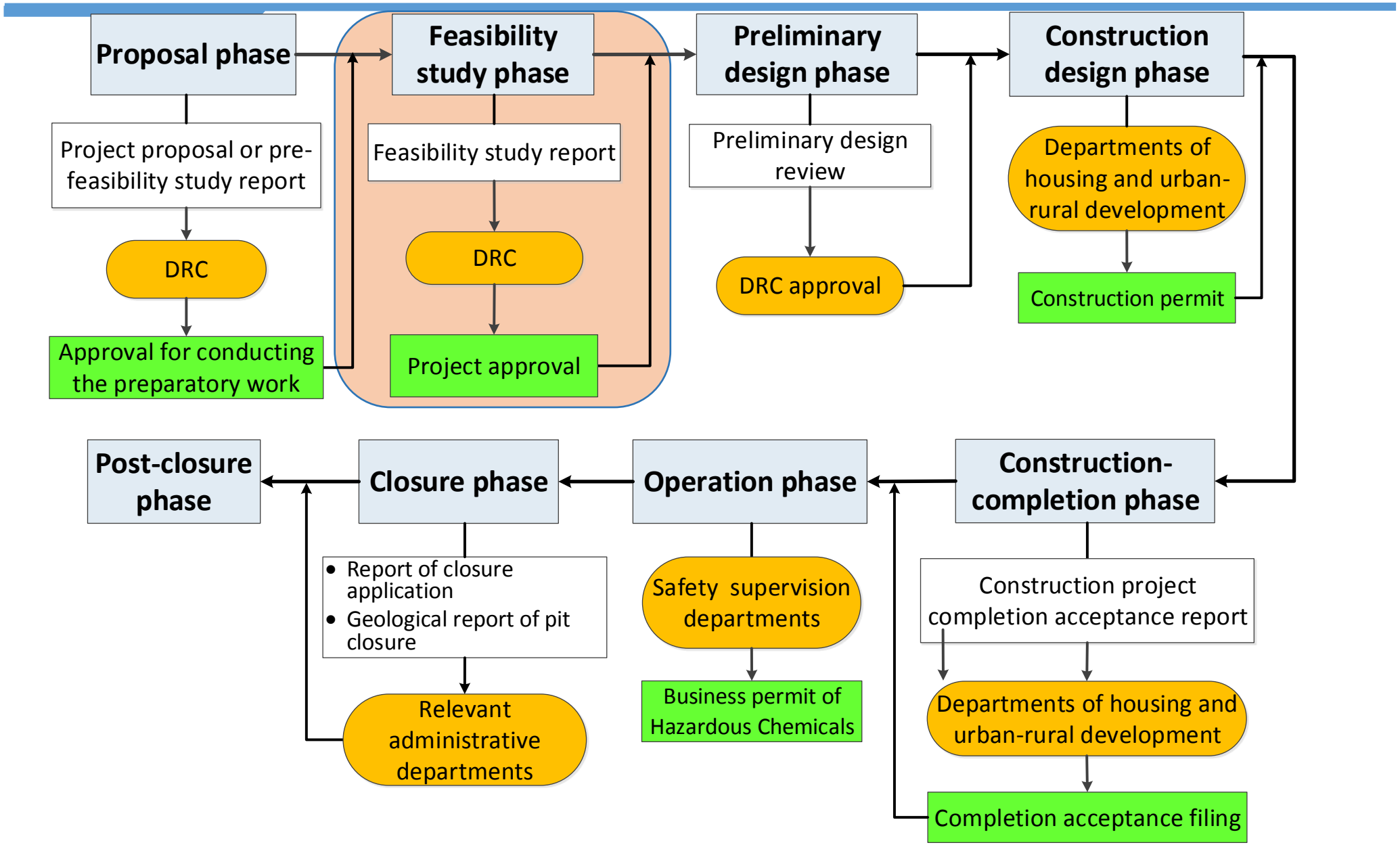
- Proposal or pre-feasibility study report
- Fund application report

Approved by the Development Reform Commission

- Conduct pre-feasibility study
- Submit PFS report or project proposal and fund application report to DRC;
- DRC issue “approval for conducting the preparatory work”, according to relevant policies, plans, etc.

- 开展预可研研究；
- 向发改委提交预可研报告或项目建议书和项目资金申请报告；（使用政府性资金的项目为“审批制”）
- 发改委签发同意开展可研工作的函。

Regulatory system for construction projects



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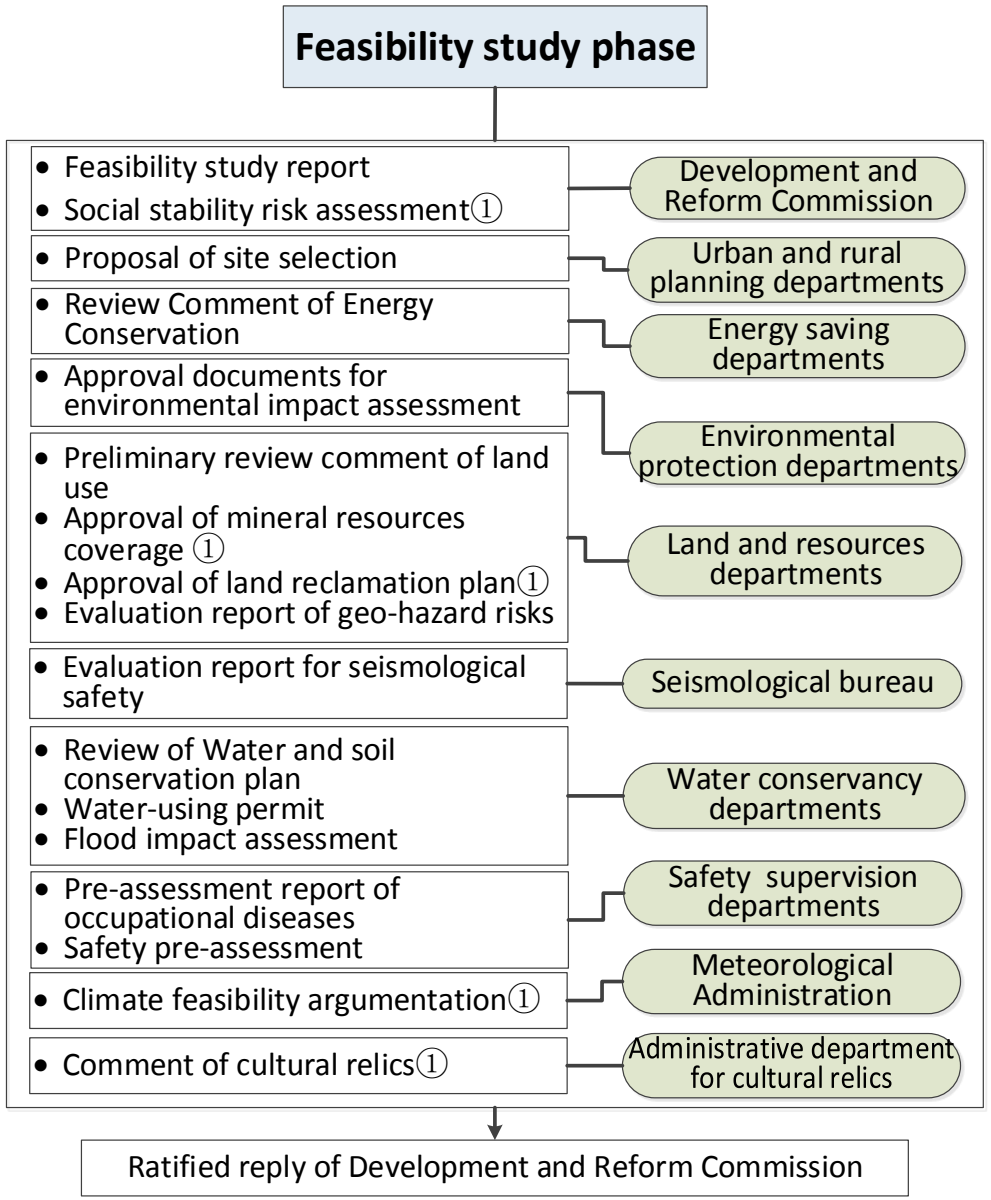
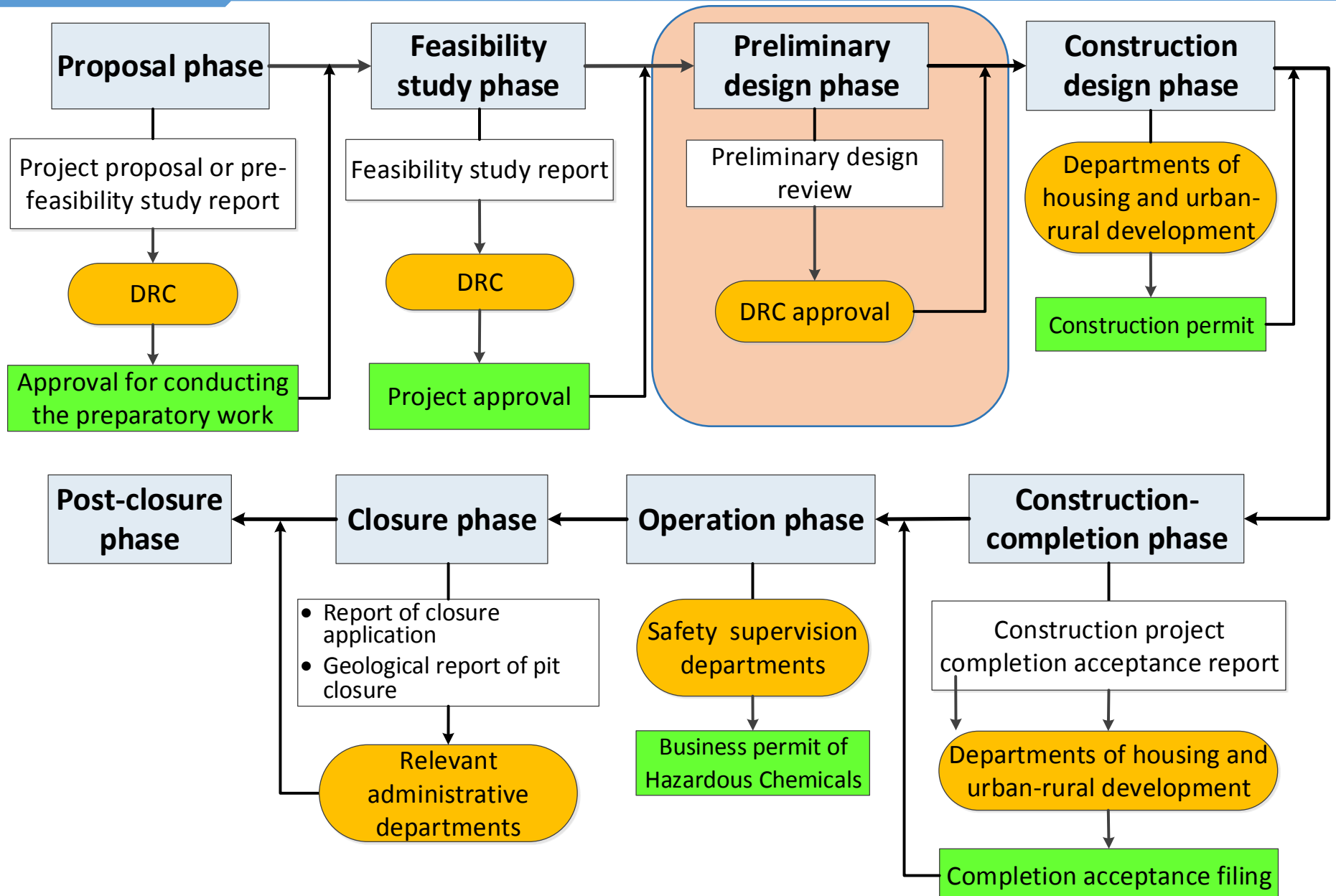


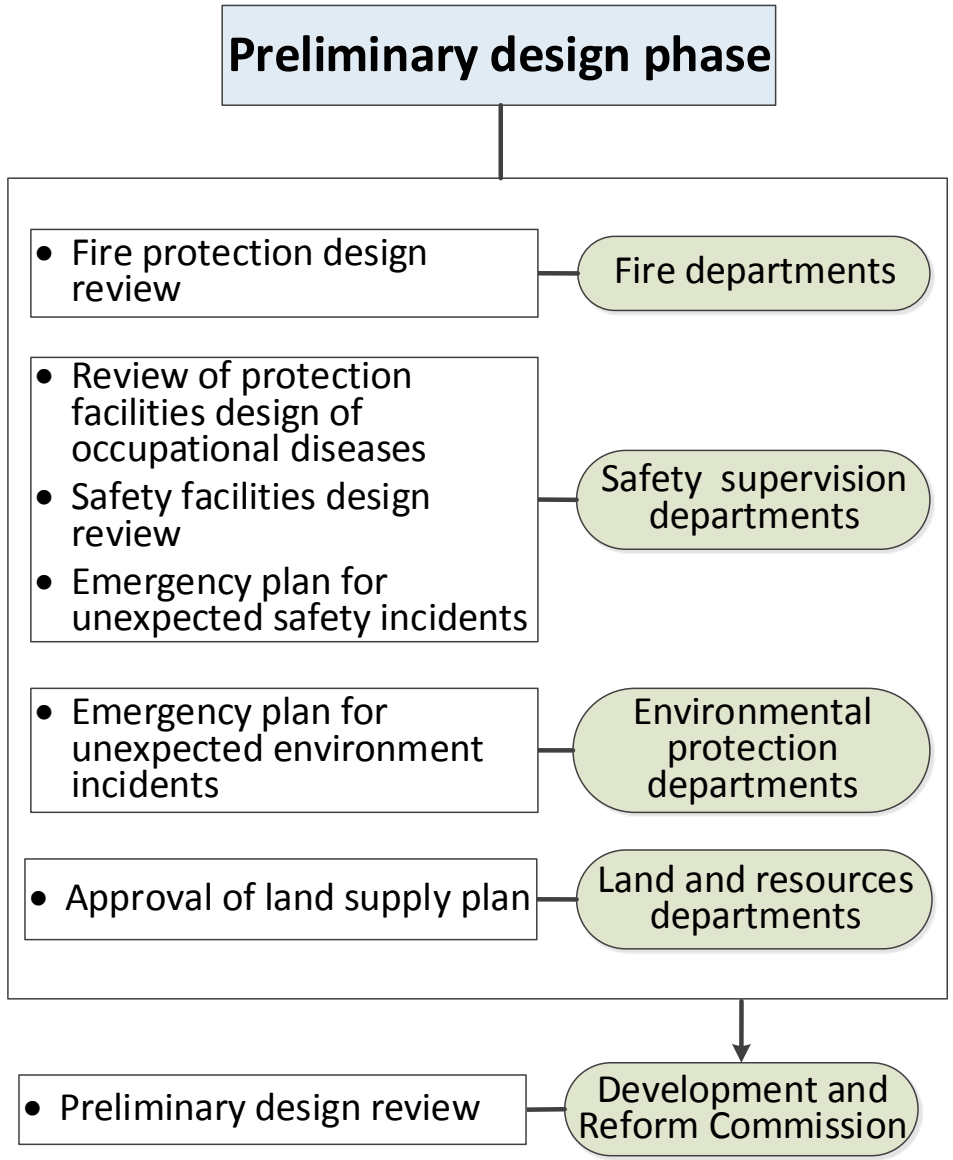
- Submit dedicated reports to the authorized bodies to get specific approvals.
- Submit the feasibility study report with the above dedicated reports to DRC for permit and filing.
- Involving several governmental departments.

- 向相关部门提交专篇报告；
- 可研报告连同批复的专篇报告提交发改委申请立项批复并备案；
- 涉及发改委、城乡规划、节能、环保、国土、地震局、安监、水利和海洋主管等多个部门。

Regulatory system for construction projects

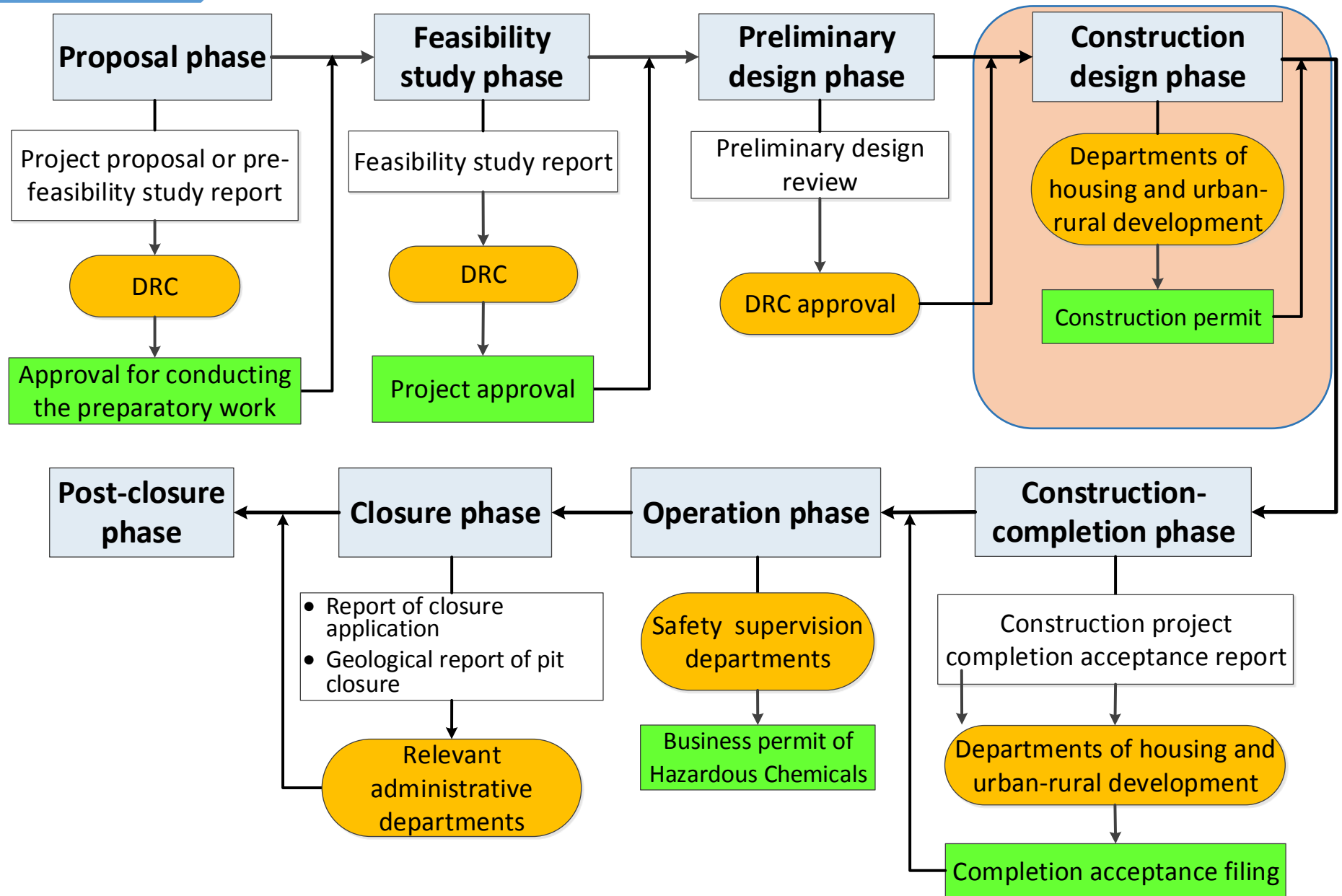


Regulatory system for construction projects



- Submit the specialized designs to the corresponding administrative departments for review and inspection.
- Submit the preliminary design to DRC for review;
- 相关单位对初步设计中的专项设计审查（消防、安监局、环保、国土等）；
- 发改部门作初步设计批复；

Regulatory system for construction projects



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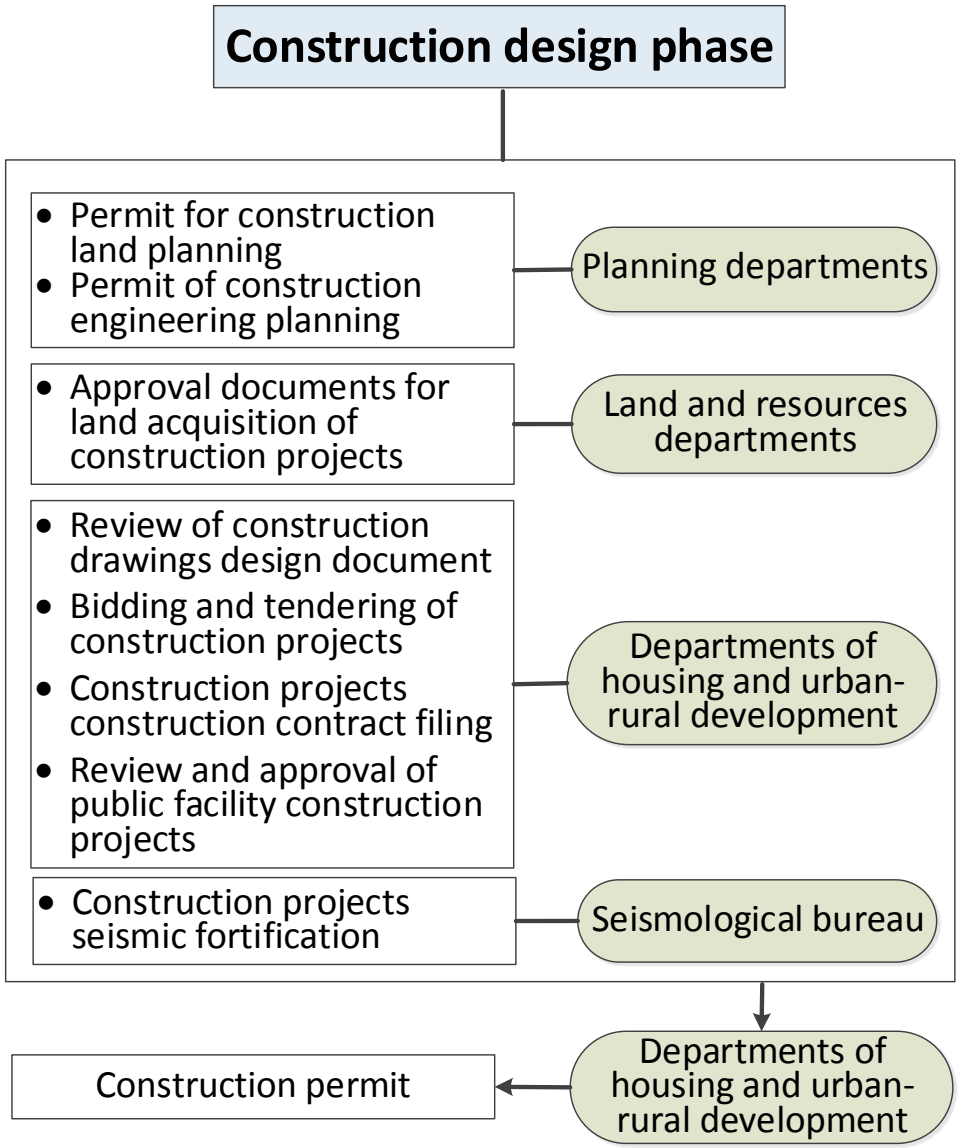
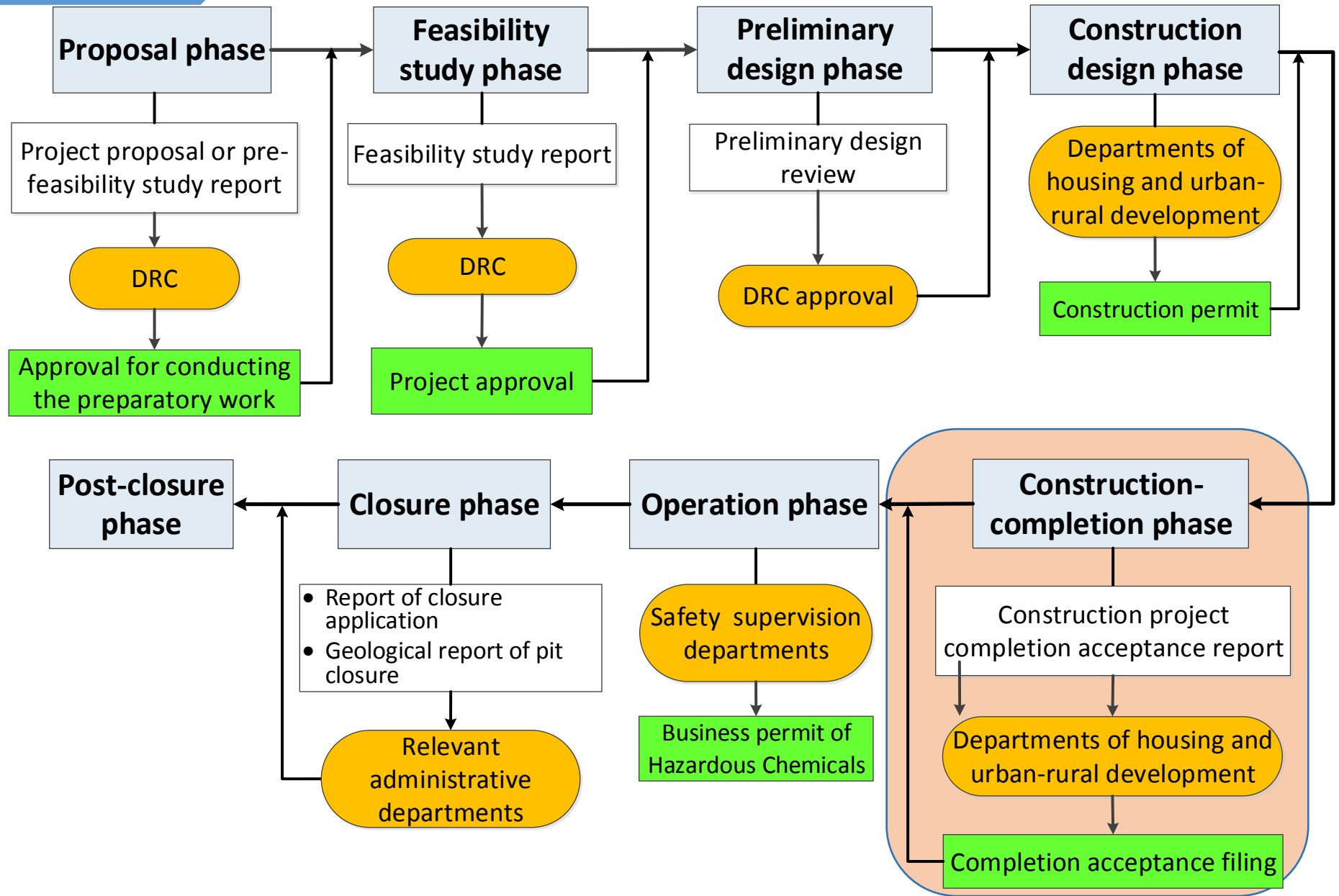


- Submit a series of construction documents to the relevant administrative departments.
- Departments of housing and urban-rural development issues construction permit .
- 向国土部门、住建部、规划部门、地震局提交申请文件，政府部门签发许可证和批准文书；
- 住建部签发施工许可证；

Regulatory system for construction projects



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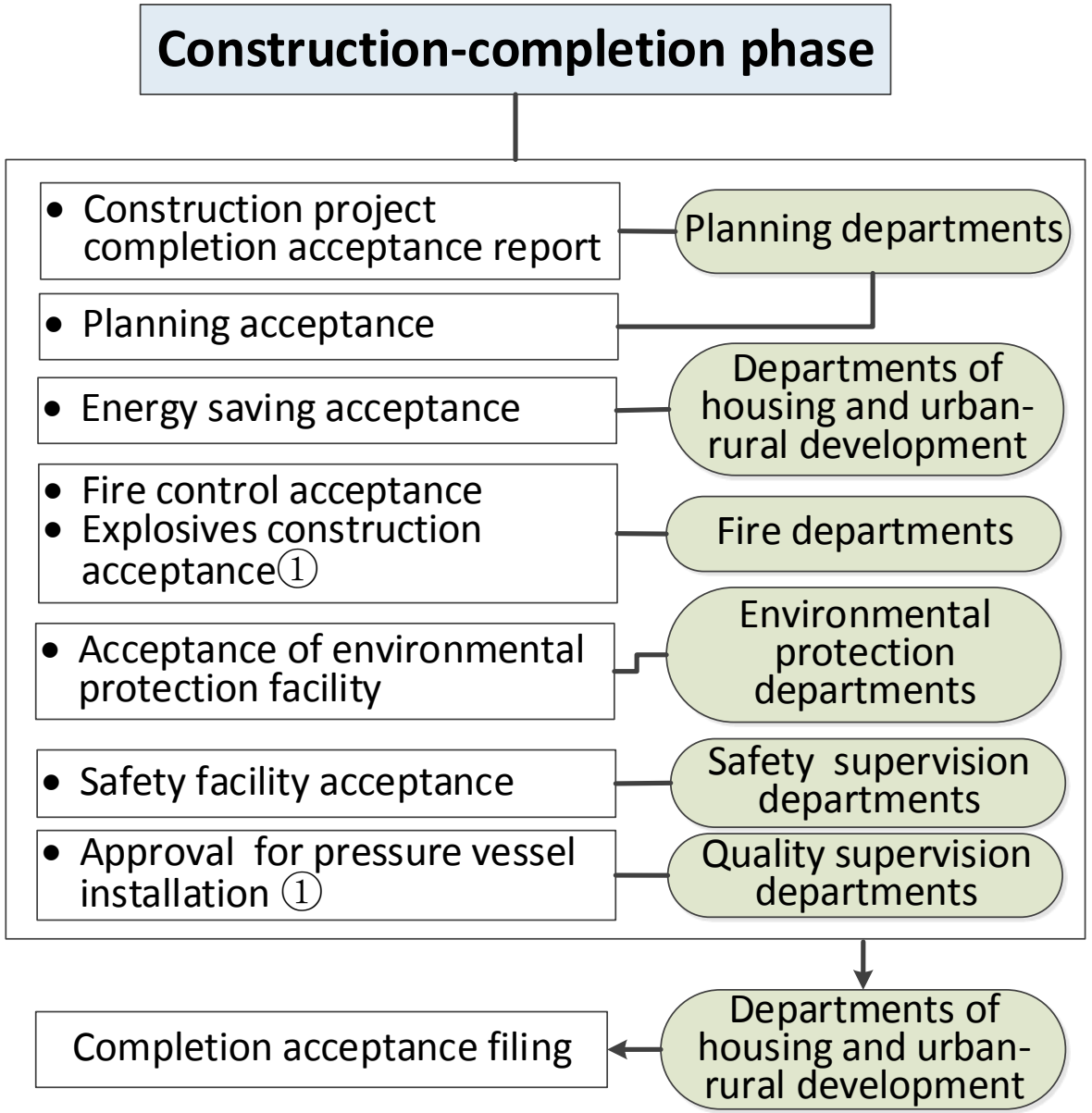

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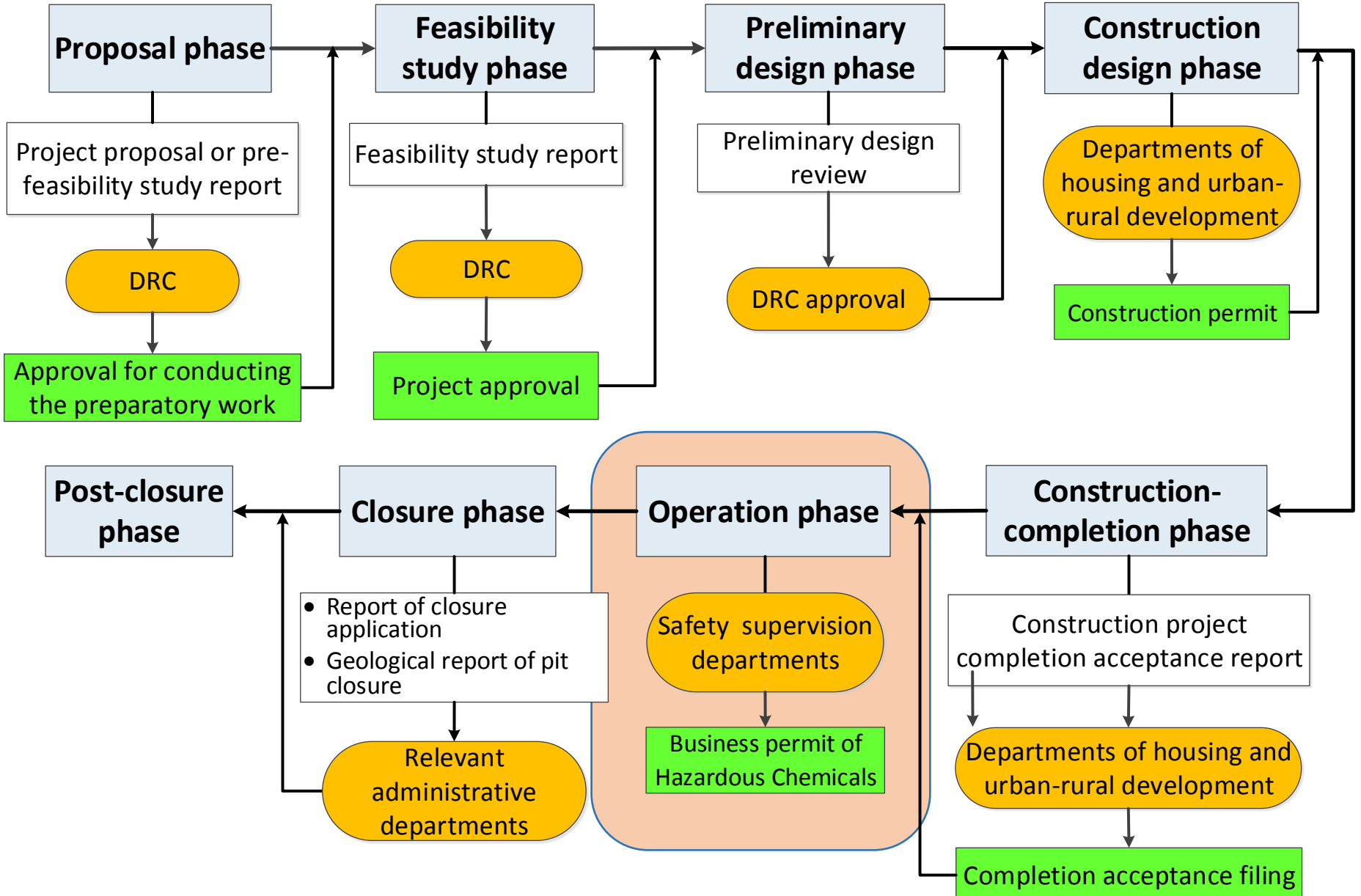

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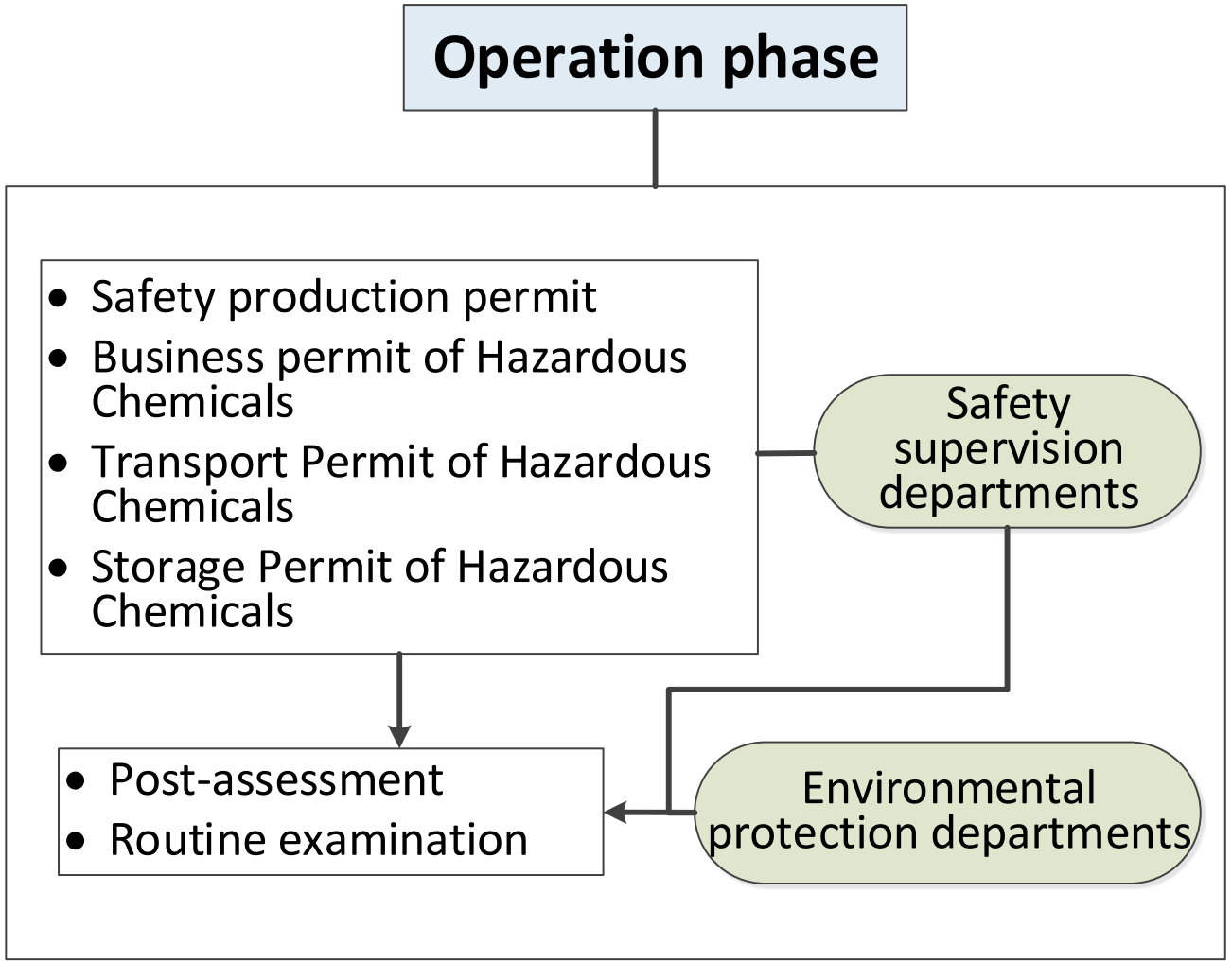
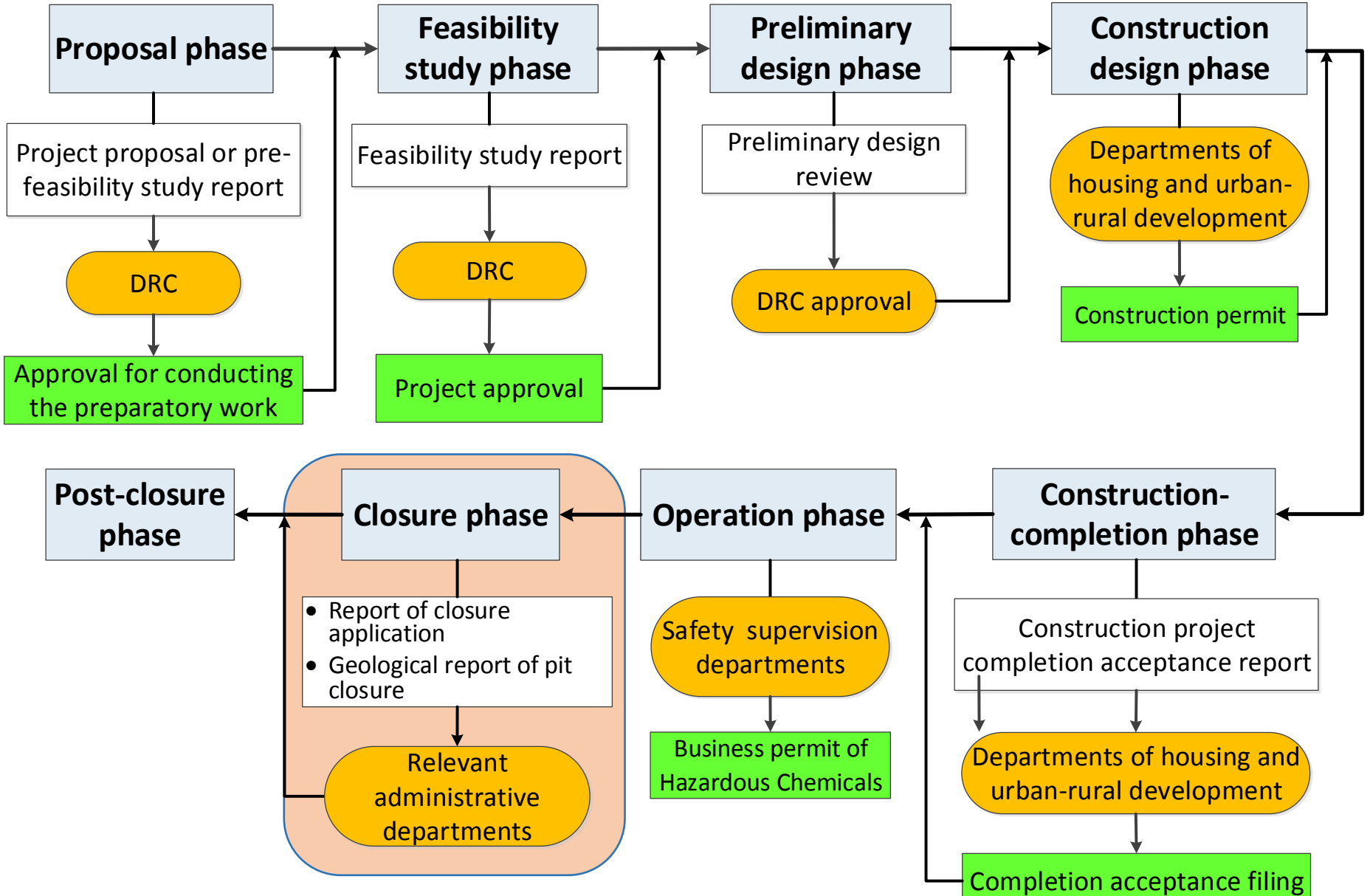
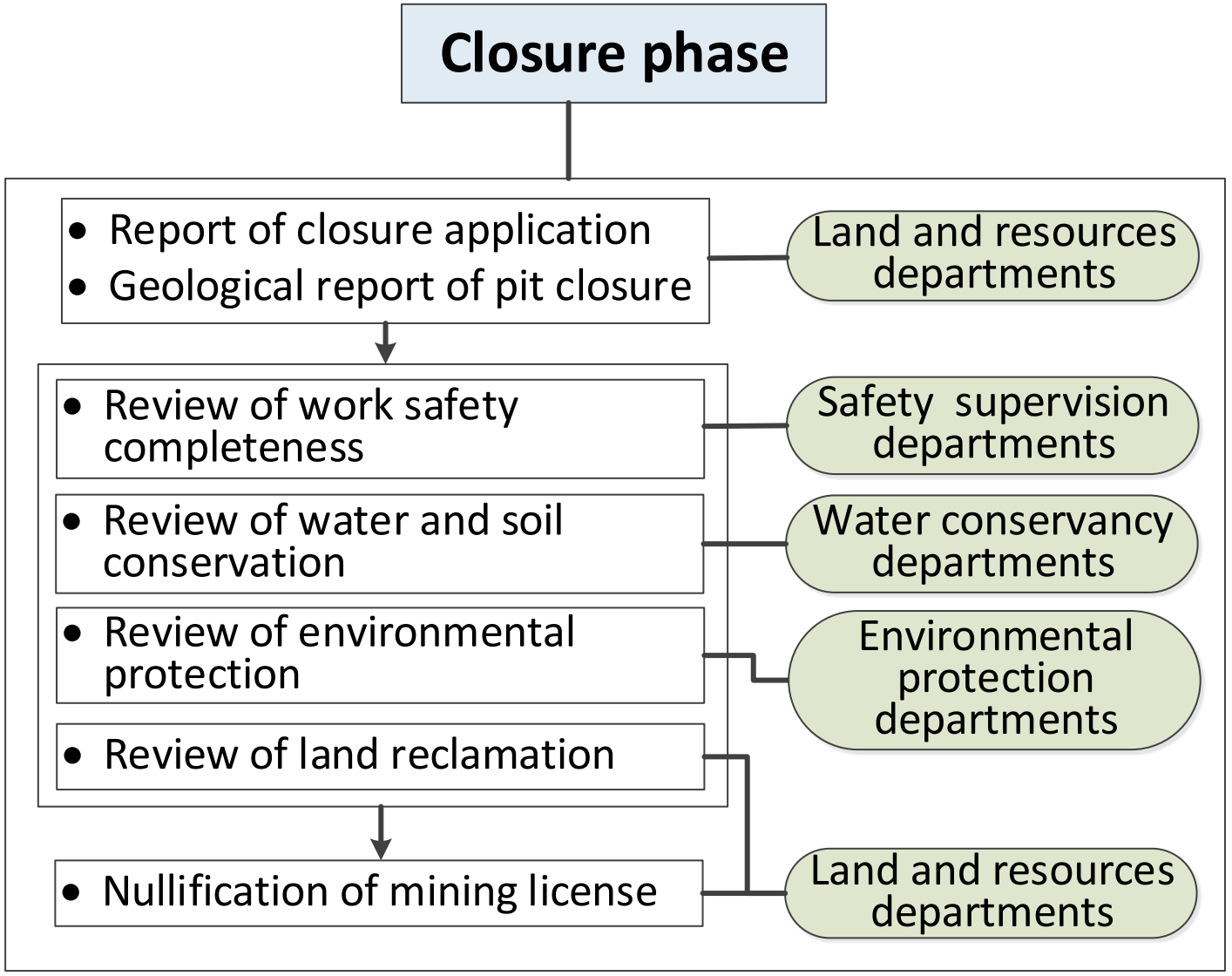


- The relevant supervision departments issue licenses for operation;
- Safety supervision departments and Environmental protection departments will periodically inspect the construction project during operation.
- 监管部门签发危化品运营许可证；
- 安监部门和环保部门常规检查；

Regulatory system for construction projects

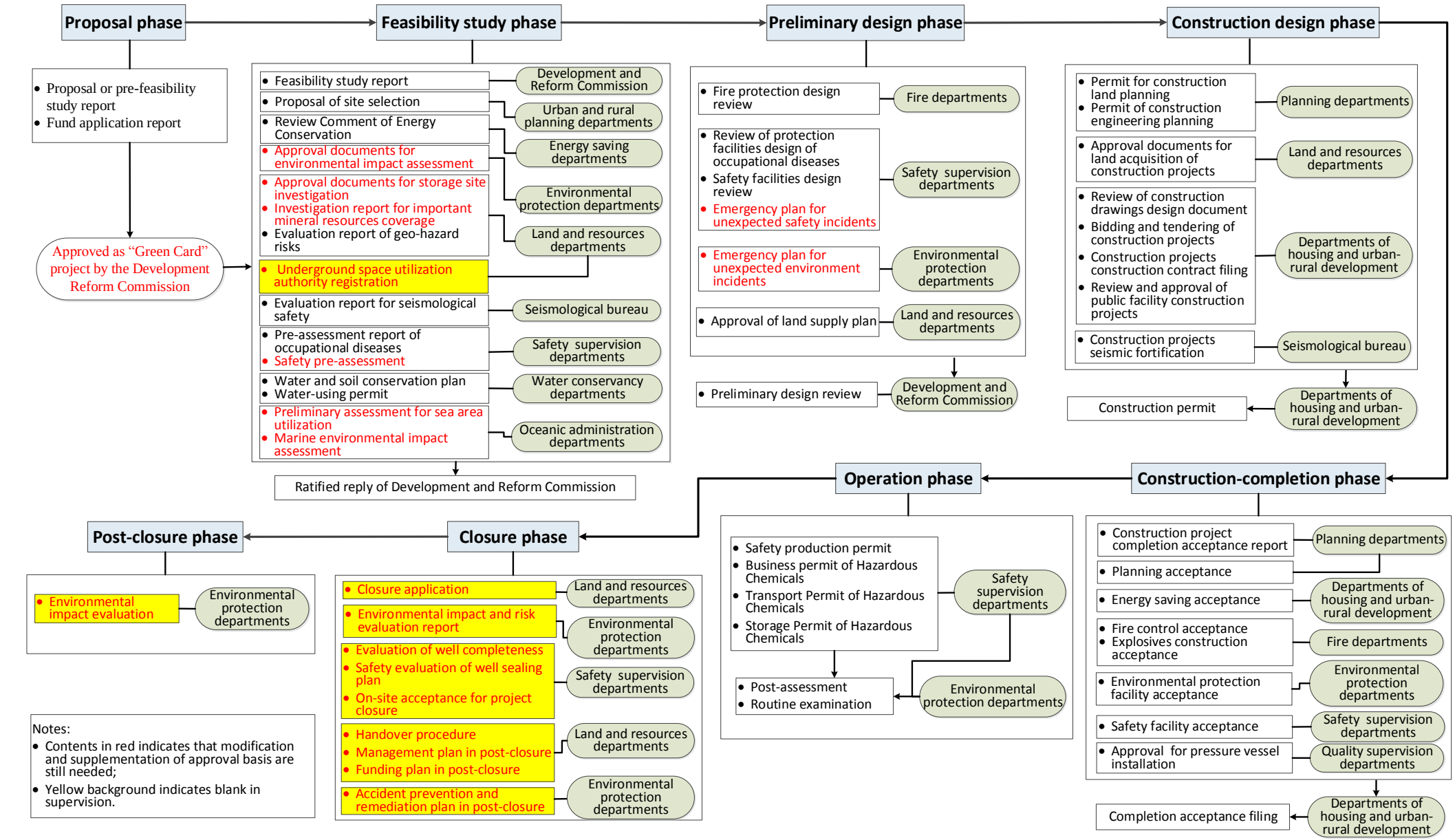


Regulatory system for construction projects

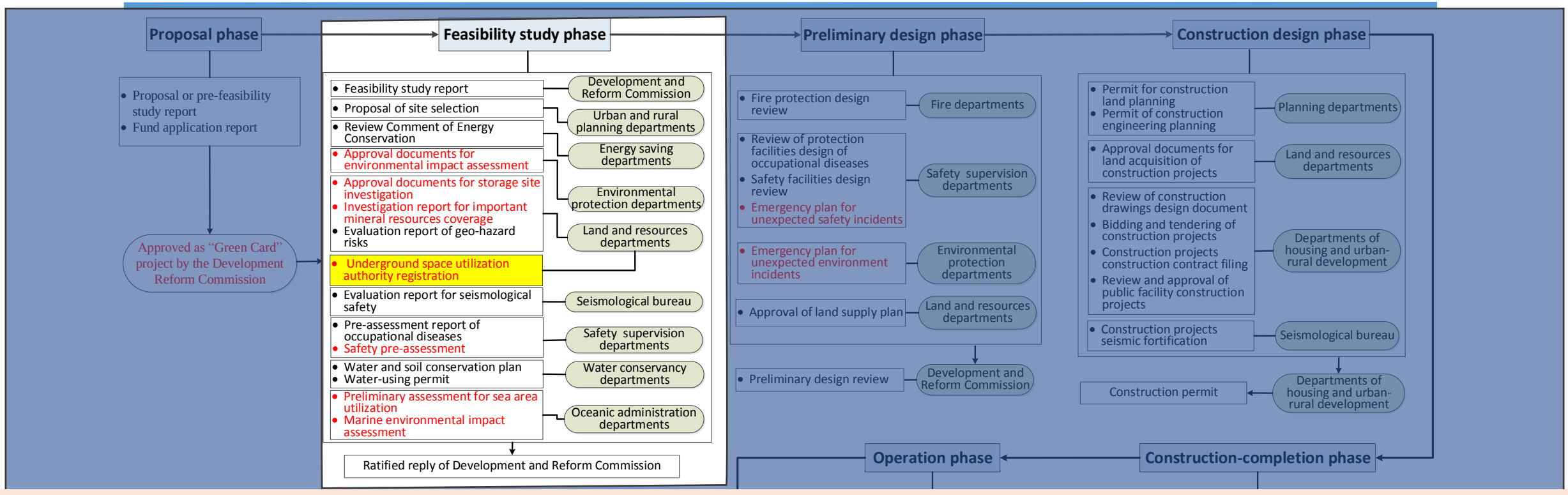


- In mining industry, the closure regulatory is comparatively mature.
- 关闭阶段，矿产开采行业有一些法规可参考。

Regulatory system of CCS projects



Regulatory system of CCS projects

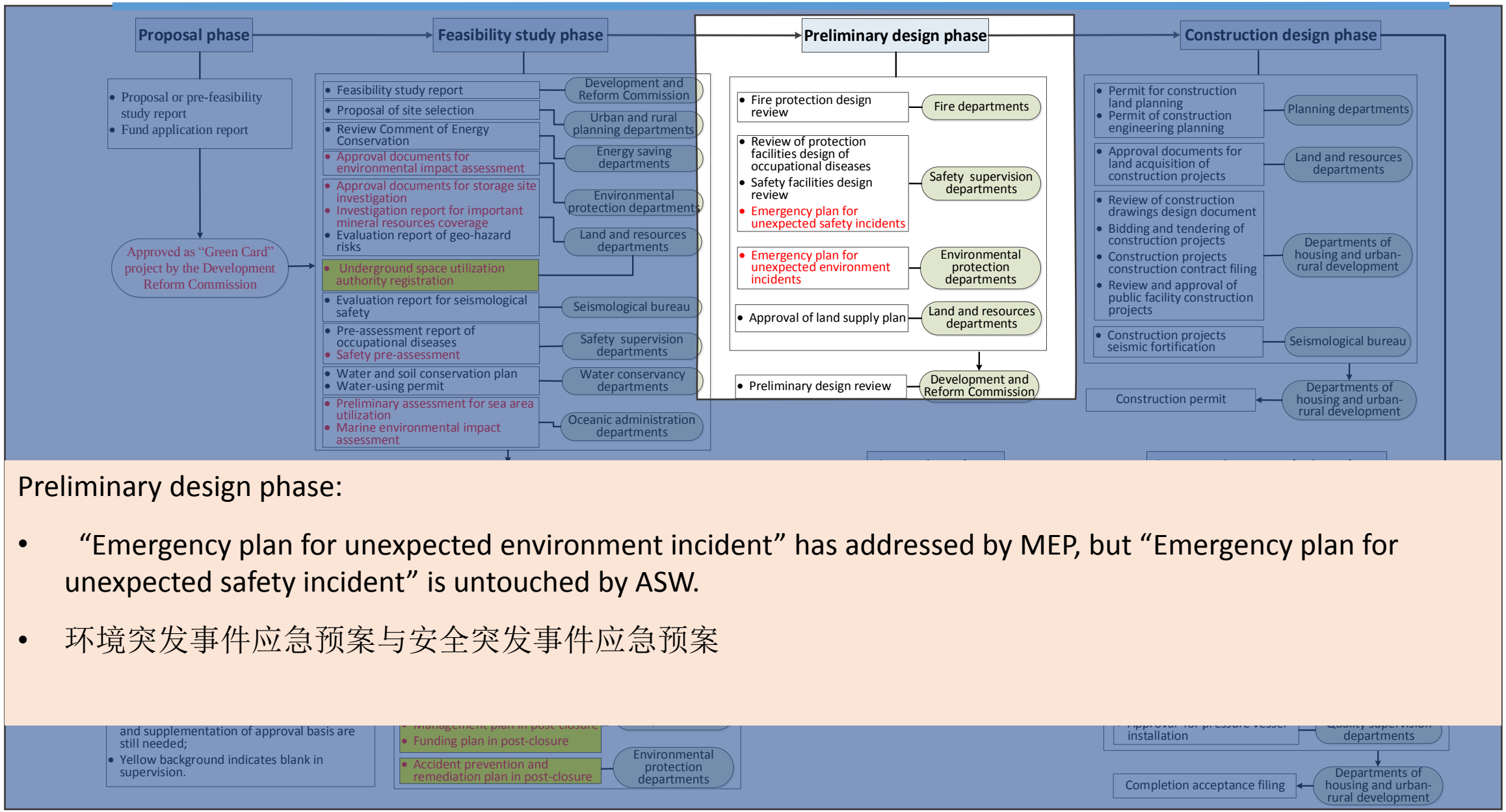


Feasibility study phase :

CO2 classification in CCS projects: hazardous chemical A2.2 危化品A2.2类

- "*CCS Environment Risk Assessment Technology Guide*" is being publicized. 环境风险评估技术指导则正在公示，可借鉴
- Storage site investigation; 封存场地选址方面
- Conflict between CCS projects and mineral resources projects is being studied.资源压覆问题正在研究
- Safety pre-assessment (induced earthquakes unclear) 安全预评估方面，大部分项目，由CCS诱发地震问题需研究
- Off-shore storage ： storage site selection and environmental assessment； 海洋封存方面需研究选址和环评
- Underground space utilization authority registration； 地下空间利用权属问题

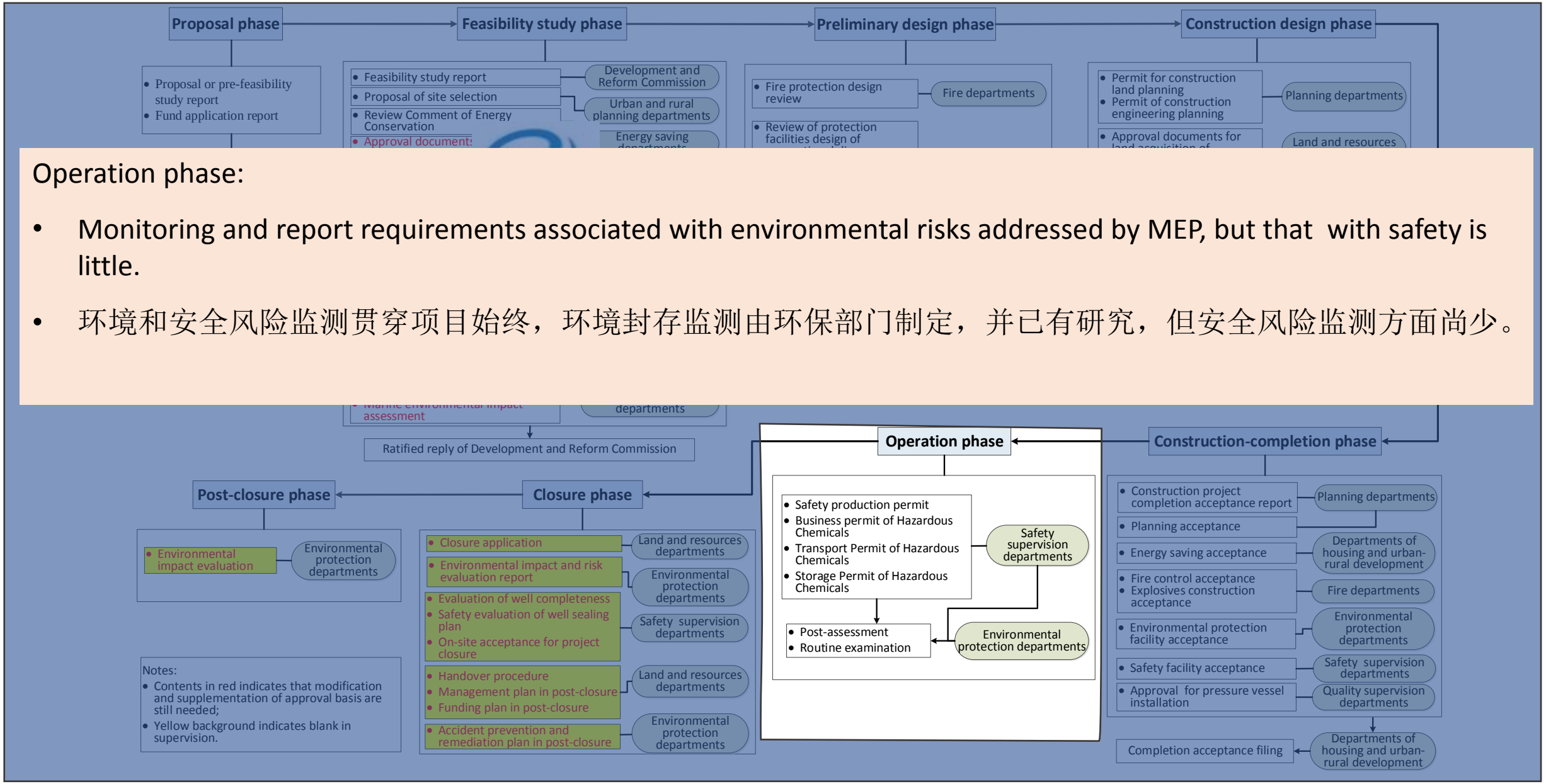
Regulatory system of CCS projects



Preliminary design phase:

- "Emergency plan for unexpected environment incident" has addressed by MEP, but "Emergency plan for unexpected safety incident" is untouched by ASW.
- 环境突发事件应急预案与安全突发事件应急预案

Regulatory system of CCS projects



Operation phase:

- Monitoring and report requirements associated with environmental risks addressed by MEP, but that with safety is little.
- 环境和安全风险监测贯穿项目始终，环境封存监测由环保部门制定，并已有研究，但安全风险监测方面尚少。

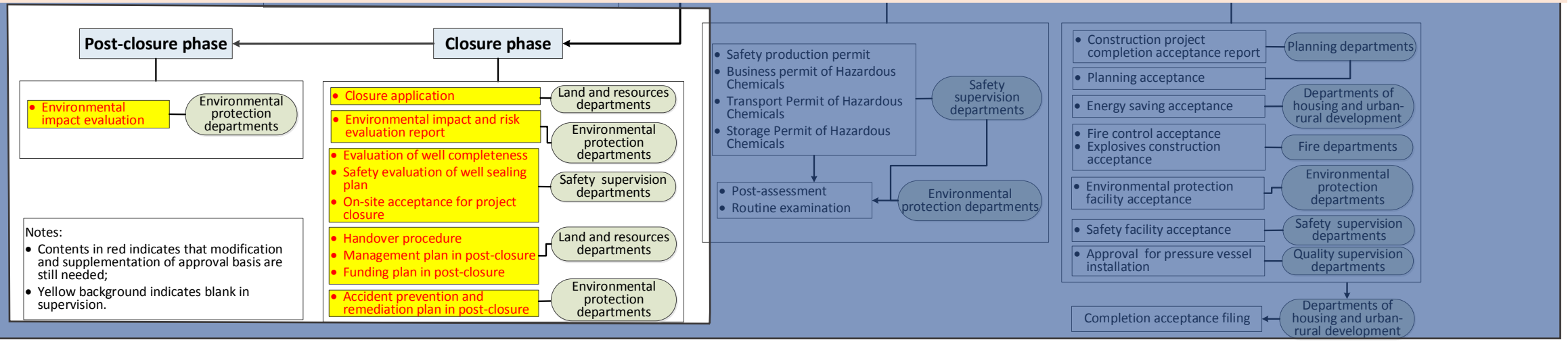
Regulatory system of CCS projects

Closure phase: No regulation.

- Closure application；关闭申请
- Environmental impact and risk evaluation report ； 环境影响风险评估报告
- Evaluation of well completeness；井身完整性评估
- Safety evaluation of well sealing plan ； 封井方案安全性评估
- On-site acceptance for project closure ； 工程关闭现场验收
- Handover procedure ； 移交规程
- Management plan in post-closure；关闭后管理方案
- Funding plan in post-closure；关闭后资金支持方案
- Accident prevention and remediation plan in post-closure关闭后事故预防与补救方案

Post-closure phase: No regulation.

- Environmental impact evaluation；环境影响评估



Summary 结言

- **Large scale integrated CCS projects：**
  - More cross-cutting risks, less experience; need A comprehensive and systematic assessment;
  - 交叉风险增加，且经验少，需要全面、系统的评估
- **Referential experience： Denbury、Kinder Mogan**
  - The earlier the better: planning phase 越早越好：规划阶段
  - Process management: all phases 过程管理：贯穿各个阶段
  - Assessment method: for more than 60 types of risks评估方法：适用于不同类型风险的60多种
- **Regulation of demos：**
  - Approved as a “green card” project; 特批为“绿卡”项目；
  - Filing on province level, communication between enterprises and governments, avoiding cross-border; 省级备案、业主与部门的沟通、少跨区；
  - Obtain Mining right, no other resource conflict; 已获采矿权、无其他资源冲突