



**Sistemas HVDC**

**SESIÓN 1 :  
Aspectos claves del diseño y especificación de sistemas HVDC**

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# HVDC SPECIFICATION DEVELOPMENT



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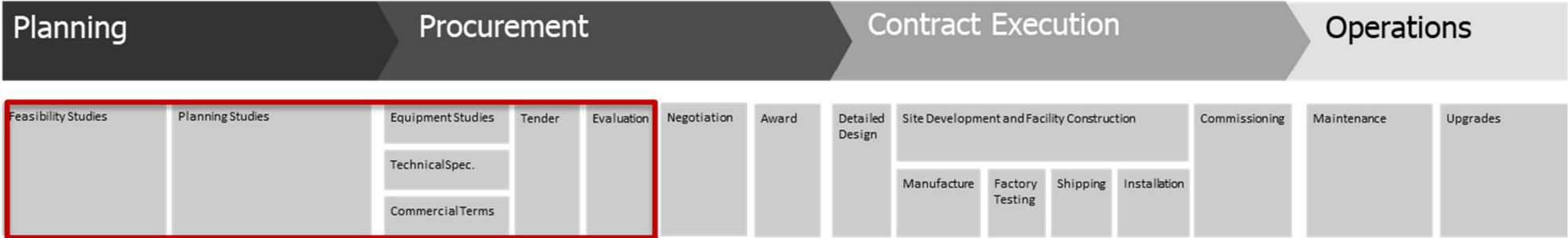
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# HVDC System Life Cycle

## Life Cycle of an HVDC System

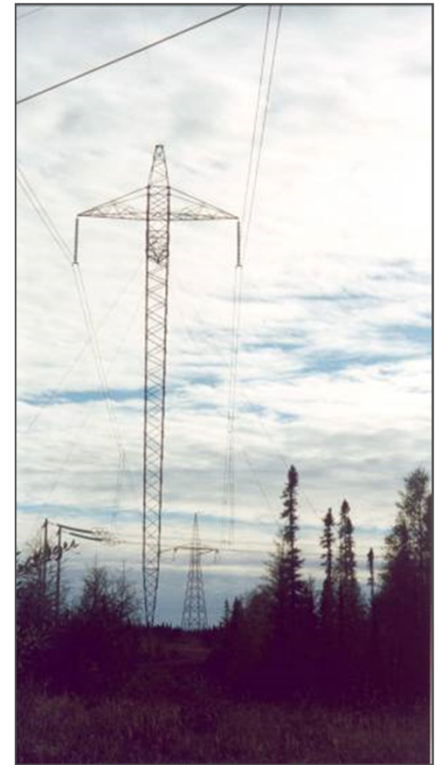


## Typical AC Project Development

- Project designed/developed by utility/TFO using standard design and equipment specifications. **Not a significant amount of customization.**
- **Self performed all or parts** thereof (engineering, procurement and construction) or developed under an EPC contract **lead by an EPC contractor.**
- Equipment usually sourced from a **variety of different vendors.**
- The major risk is **construction.**

# Typical HVDC Project Development

- Project procured by utility/TFO under an EPC arrangement (**not self performed**).
- **Manufacturers complete detailed studies, design and integration of the equipment to form the HVDC system.**
- **Manufacturers typically lead the project** who engage or partner with contractors to perform the construction and installation portions of the project.
- Bidding documents contain the technical and commercial requirements for supply of the **HVDC System (not individual pieces of equipment)**.
- Major risks are **technical** and construction.



## HVDC Project – Need To Consider

- There are a **limited number of HVDC manufacturers**.
- High reliability and availability expectations
  - HVDC Systems typically can significantly impact the AC network.
  - Outage costs are generally significant.
- **AC System upgrade costs** associated with addition of an HVDC system can be significant.
- **Operating and maintenance** practices are unique.
- **HVDC project risk profile** is unique.

# Project Feasibility and Planning Studies

- **Define a rating** (nominal, overload requirements, transient).
- **AC System studies** need to identify any system upgrades, remedial action schemes or special control functions.
- **Consult with stakeholders** inside and outside of the company to make sure applicable issues are addressed (operations and maintenance for instance).
- **Budgetary pricing accuracy.** A good practice has been to issue a mini-spec with sufficient detail and allow a reasonable amount of time for suppliers to respond.
- When comparing alternatives **include the full project life cycle costs** (losses, O&M costs, future refurbishments, owners costs, escalation etc) and **additional benefits to the system** over the useful life of the asset.
- **Get manufacturers buy-in** to the project.



# Specification Development

- The specification is a contract document, **detailed technical specifications are critical** to provide manufactures with the appropriate information and requirements, get accurate bids and avoid future issues.
- **Don't ignore the 'little things'** – auxiliary systems need to be looked at carefully as they impact cost, reliability, availability and maintainability.
- Avoid requirements which force the manufacturer to deviate from their **core design** and standard offering.
- Define your **reliability requirements** - impact project configuration, levels of redundancy and spare equipment requirements.
- Define **utility and regional environmental requirements** (communication interference, audible noise, power quality, harmonics, pollution etc.).

# Specification Development

- **Equipment studies need to be completed** to get functional and performance requirements and provide a common set of system data for the bidders:
  - Define real and reactive **power exchange requirements** (normal and overload as well as dynamic response requirements, ramp rates etc).
  - Identify any **special control requirements** (damping, modulation, special operating modes, SPS etc.) or at least have a provision for this.
  - Provide **system equivalents and other system data** for all bidders to get pricing based on consistent inputs and not based on varying assumptions.
  - Provide **background harmonic measurements** to address possible filter requirements and to avoid any possible resonant conditions which can limit power transfer.
  - Provide **system harmonic impedance**.



# Specification Development

- Provide any applicable internal **standard equipment specifications** e.g. standard ac breakers, battery banks, chargers etc.
- Consider requesting equipment to be provided from factories that are **recognized centers of excellence**. Have bidders identify factories of origin.
- Specify **maximum replacement times** for major pieces of equipment (transformers and reactors).
- Specify **digital simulation models** to be provided, and the level of detail. Be aware of Intellectual property concerns.
- **Penalty clauses** for losses, availability, failure rates are useful to ensure expected performance and consequences are defined. Feed into the commercial specification.
- Define any **transportation limits** as they may impact design and delivery of major components such as transformers.

## Specification Development

- **Factory testing** needs to be properly defined – What configurations to be tested? What happens when certain tests are not passed – at what point can an order be rejected entirely?
- Specify **documentation and training** to be provided.
- Specify **mandatory and optional spare parts** as well as any **special tools and maintenance equipment**.
- **Civil is a significant risk item**, do some ground work, provide as much detailed information at the specification stage as possible.
- The design should **consider future refurbishment requirements** such as controls.
- Include in the process time to solicit comments from suppliers on draft specification and commercial terms. **Get manufacturers buy-in.**

## Tendering

- Allow **sufficient time** for manufacturers to respond.
- Allow **sufficient time** complete thorough evaluation.
- **Prepare tender forms** requesting specific information from the bidders in common format to facilitate careful review and comparisons between vendors.
- **Develop evaluation criteria** early and stick to it.
- Prepare a **conformed specification** after award taking into account all negotiated deviations.



# Gracias

