Capacity building seminar on planning, design, development and operation of intermodal freight interfaces, including dry ports

Part 3: Concepts and methods for designing and operating dry ports

Peter Hodgkinson, Consultant Transport Economist UNESCAP
1. Broad principles
2. Key principle for CY design: good rail access
3. Road access
4. Customs security
5. Container yard (CY) design and operation
Item 1. Broad principles

- Not necessary for dry ports to have identical design standards to function effectively as inter-related components of regional network
- But, there is need for some consistency among them as to basic services offered and design of infrastructure needed to provide these services

Basic services:
- Handling, consolidation, storage and modal transfer of containers and cargo;
- Customs and other border control inspection and clearance of international cargo

Basic infrastructure needs:
- Fenced customs secure area - segregated entry/exit points for different traffic;
- Container Yard (CY) – receipt/despatch of containers by road and rail, container storage;
- Container Freight Station (CFS) for loading/discharge of cargo to/from containers;
- Customs inspection area where cargo may be discharged for inspection;
- Bonded warehouse for storage of break-bulk under bond cargo
- Administration building (dry port management, customs, freight forwarders)
Item 2: Key principle for CY design: *good rail access*

Rail infrastructure to be provided inside a dry port should allow receipt and despatch of **full length unit container trains** running between **a single origin and a single destination**, without need to be broken up or re-marchalled outside the dry port

- **CY should be designed around rail access and not the reverse**
- Loading and unloading of trains would take place in centrally located sidings comprising **at least** three tracks – loading, unloading and locomotive release
- Actual number of tracks depends on forecast traffic volumes
- For a reach-stacker served facility, container stacks of CY located either side of the tracks (to allow for separation of import and export containers and for loading and unloading on both sides at a time)
- Paved area of CY on which stacks rest would extend entire length of tracks
2.1 Possible layout of dry port (reach-stacker served terminal)
Example of good rail access planning (1): Lard Krabang ICD (Thailand)

- Rail loading/unloading tracks centrally located, permitting working of handling equipment on either side.

- Tracks are one km long, permitting full length trains (loco plus 30-40 wagons carrying 60-80 TEU) to arrive and depart directly in/from the terminal.
Example of good rail access planning (2): Whitefield ICD (India)

- Rail access directly from/to Bengaluru-Chennai mainline
- 2 access tracks, one each serving export/import container stacks and domestic container stacks
- 2 loading/unloading tracks in each section (900 m long = 62 x 2 TEU wagons; actual/train = 45 x 2 TEU)
- Loading/unloading tracks placed centrally between container stacks
- All lifting (trains and stacks) by reach-stacker
- Annual handling capacity (estimated by consultant): 232,000 TEU
- Electric traction (approach track to sidings is wired)
Example of good rail access planning (3): Uiwang ICD (Rep.Korea)

Terminal 1

- Rail access directly from Uiwang Marshalling Yard
- 3 access tracks each switched into 3 loading/unloading tracks of about 570 m length
- Trains of 30x2 TEU and 20x3 TEU wagons

- Loading/unloading tracks placed centrally between container stacks
- Trains loaded/unloaded by RTGs; reach-stackers work stacks
- Annual handling capacity (2 terminals): 1.37 million TEU
2.2 Planning for track length and number

Track length

- Length of loading/unloading tracks determined by number and length of wagons comprising a train
- For a train of 40 container wagons pulled by a single locomotive, length = 1 loco x 22 m + 40 wagons x 14.45 m + 10% allowance for braking and loco release = 660 metres approx.
- Length should not be planned for current train lengths, but for likely future economic lengths, based on advice from railways

Number of tracks

- Required number of loading/unloading tracks determined on basis of forecast container handling volume, number of trains operated and average train turnaround times
- To this number must be added an additional track for release of locomotive(s)
2.3 Influence of traction type on track layout

- Figure presented illustrates layout applying for a diesel hauled train, whereby the train may be hauled directly into and out of the sidings by the train locomotive (which uses a “free track” to reverse to the other end of the train)

- In limited number of cases where electric traction employed, **will be necessary to construct reversing tracks outside dry port boundary** to allow electric locomotives to re-position to end of train and push into sidings inside dry port

- This is necessary to avoid interference of electrical catenary with high rise container handling equipment operating inside terminal

- In this case only first 30-40 metres of siding track would need to be electrified
2.4 **Choice of track construction type and axle load**

- Except for two lengths of ballasted track, containing points and crossings, or switches, at either end of the rail yard, loading/unloading tracks should be embedded in the pavement to allow for ease of reach-stacker working.
- Design axle load in rail yard should be compatible with that of the mainline railway network.
- For metre gauge railways this is now typically 20 tonnes, while for wider gauge railways it is typically in the range of 22.5-25 tonnes.
- Even at lower level, axle load sufficient to accept heavy axle load locomotives and wagons carrying two fully loaded 20ft containers or a single 40 ft container.
Item 3. **Road accesses**

- Road connections to dry port will be via slip roads off local or national highway system.
- In most cases, connections provided by responsible road infrastructure authorities (local or national highway agencies).
- Road connections should be suitable (in terms of pavement condition, alignment, load bearing and gradient) for container and break-bulk trucks conveying containers or break-bulk cargo between cargo sources and the dry port.
Item 4.  Customs security

- Whole of dry port will be customs secure area
- Will need to be fenced in accordance with local Customs Agency regulations
- Where there is to be provision for handling other types of cargo in addition to containers, there needs to be separate working areas and security accesses or gates for each
- Explains why it is generally uneconomic to handle multiple cargo types within a dry port
5. Dry port design and operation

5.1 CY layout determined by choice of handling system

- **Layout** depends on number and length of rail siding tracks as well as type of handling system to be employed
- Choice of container handling system (**reach-stacker** or **portal crane** system?) will in turn depend on expected volume of containers to be handled:

**Reach-stacker:**
- has wide turning circle, is therefore land area intensive, and has slow handling rates (**typically only 12-15 lifts per hour**).
- advantage is a low capital cost, ranging from US$ 500,000 (for an Indian manufactured Hyster unit) to US$ 800,000 (for a new Kalmar unit)

**Portal crane system**, either a **rail mounted gantry (RMG)** or a **rubber tyred gantry (RTG)**, crane:
- can accommodate denser stacking of containers, is therefore less land area intensive, and has fast handling rates (**typically 20-30 lifts per hour**)
- disadvantage is a high capital cost (about US$ 1.6 million for an RTG and US$ 2.6 million for an RMG)

- In general reach-stacker suitable for throughput volumes up to 200,000 TEU p.a., but this system is now handling nearly 465,000 TEU p.a. of rail-hauled containers at Lard Krabang
- Owing to much higher cost, portal crane systems are justified for throughputs in vicinity of 1.0 million TEU p.a.
Pictures of container handling systems

Reachstacker in operation, India

RTG transferring containers rail to road, ROK

RMG discharging containers from rail, ROK
5.2 CY layout, capacity and pavement design

For a reach-stacker served terminal

- Two CY sections placed either side of loading/unloading tracks to separate import and export containers
- At least two reach-stackers will work one train at a time (working along the length of the train), lifting containers directly between wagons and container stacks in one of 2 CY sections, avoiding need for trailer transfer
- With increase in number of reach-stackers, loading/unloading can be done simultaneously on both sides of the tracks (i.e. simultaneous handling of import and export containers)
- In each CY section, container stacks will be arranged in blocks of about 4 TEU wide, 3 TEU deep and 3-5 TEU high, along the length of tracks, each separated by a width of 13 metres to allow for reach-stacker turning circle. Storage capacity = 1,300 TEU approx.
- Annual throughput capacity depends on number of times CY storage volume is turned. In this case average dwell time of a container cannot exceed 4.5 days for throughput of 100,000 TEU
- To minimize capital cost, CY can be constructed in flexible paving materials, but will have to withstand heavy wheel loadings of container lifting equipment (reach-stacker lifting 45 tonnes = 25 tonnes per wheel).
For a portal crane served terminal

- Container stack arranged in a single block along the length of the loading/unloading tracks
- Crane will straddle at least the tracks and a roadway and possibly even the container stack as well (to allow container transfers between rail and road and between rail and stack as well)
- Cranes will need to run up and down the length of the train on rails or rubber tyres as the case may be
- To minimize capital cost, CY can be constructed in flexible paving materials, but will have to be strengthened for heavy loading under the runway of the portal crane(s)
- Wheel loadings for an RTG are approximately 26-35 tonnes
5.3. **Provision for truck circulation within dry port**

- Efficient operation of dry port depends on unimpeded circulation of trucks throughout most of dry port area
- Exception is intersection with rail access line, which needs to be protected by automatic level crossing barriers and warning devices
- Internal roads should be constructed with width of 15 metres, to allow handling equipment and trucks to pass safely
5.4. **Container Freight Station (CFS) design and operation**

- Function of CFS is to pack and unpack cargo into and from containers which are moved to and from CY
- Will not include all containers handled in CY, as some containers moved outside dry port for packing and un-packing at shipper/consignee premises
- CFS should be designed with container bays facing onto a raised loading/unloading platform on one side and truck loading/unloading bays on the other
- Containers packed and unpacked by forklift trucks while still on their trailers (see picture)
- Similarly break-bulk trucks loaded and unloaded from raised platform by smaller forklifts (2-3 tonne capacity)
- Area required for CFS may be calculated on basis of some proportion of loaded import and export containers in CY moving through CFS
- Floor area of cargo discharged from these containers calculated by applying to TEU volume an average area per TEU of 30 square metres, traffic circulation factor of 1.3, and a seasonal traffic peaking factor
CFS operations

Forklift loading cargo into container (Thailand)

Forklift loading cargo onto break-bulk truck (Thailand)
5.5. Other building area requirements

- Other buildings within the dry port are:
  - **Administration building**, accommodating dry port management, customs and other border inspection officials, freight forwarders and banking and financial services
  - **Bonded and long term warehouses**
  - **Security gate office**
  - **Customs inspection facility**
  - **Workshop**

- Area requirements for these can be determined from consultation with customs and potential warehouse operators

- Warehousing area in particular can vary in line with the scale of demand – if commercial warehousing services are to be provided, building requirements could be substantial
5.6. **Terminal management IT system**

- Essential for entry, exit and placement into storage of containers and cargo to be tracked by a real time computer system.
- Should be possible to locate any container or cargo consignment from time of departure from seaport or from shippers premises to arrival in dry port and placement into storage.
- Computerized yard control system should be used to determine with precision where a container is to be placed within stack.
Item 6. Assessing trade inducement benefits of a dry port

Case study 1

- A logistics operator proposes to develop a dry port located close to an industrial zone generating a significant volume of trade (both imports and exports).
- The zone is currently connected to a seaport by a break-bulk trucking service, but in future will be connected by a short-haul break-bulk trucking service to the dry port and from there to the seaport by a rail container haulage service.
- Relative locations of the cargo generating area, the dry port and the seaport are as shown:

<table>
<thead>
<tr>
<th>Cargo transport cost between cargo origin/destination and seaport with and without a dry port</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-dry port</td>
</tr>
<tr>
<td>2. Post dry port</td>
</tr>
</tbody>
</table>
1. You are asked to assess the trade increasing benefits of the dry port if it is located:
   (i) 100 km; (ii) 200 km; (iii) 300 km; (iv) 500 km; (v) 700 km; or (vi) 1,000 km from the seaport (assuming in each case it is located 20 km on average from trade origins/destinations)

2. Your assessment will be based on transport cost data and curves as given in Excel file “Assessed DP econ benefits”, worksheet “Tpt cost estimates” and on an assumed cargo volume without the dry port equal to 50,000 TEU

3. Please note that **two estimates should be provided for each distance**, reflecting alternative trade demand elasticities \( (e_D) \) which might apply following development of the dry port

4. Are there any distances for which the dry port will not generate increased trade. If so, what are they?

5. At what distance will transport cost reductions begin to generate increased trade for the dry port?
Item 7. Assessing reduced CO2 emission benefits of a dry port

Case study 2

1. You are asked to calculate the benefits of a reduced emission of CO2 resulting from the use of rail to transport containers between dry port and seaport instead of break-bulk cargo transport by road.

2. Your assessment will be based on:
   - fuel consumption and CO2 emission rates as given in Excel file “Assessed DP econ benefits”, worksheet “reduced CO2”;
   - initially a dry port-seaport distance of 300 km
   - an assumed cargo volume without the dry port equal to 50,000 TEU;
   - a year 1 induced trade volume in the with dry port case with trade volume increasing at rate of 2% per year

3. You will then be asked to estimate the reduced CO2 emissions when:
   - dry port-seaport distance is increased to 700 km and then to 1,000 Km
   - annual trade growth is doubled to 4%
1. Purpose of case study is to test principles of dry port design and operation based on:

   • central requirement for receipt and dispatch of full length container trains
   • choice of an efficient container and cargo handling system which makes best use of the available land area

2. You are asked to make an assessment of the land area requirement and capacity of

   (i) rail loading/unloading sidings and yard;
   (ii) container yard (CY);
   (iii) container freight station (CFS); and
   (iv) major buildings such as the warehouse(s), administrative offices and customs inspection areas

   based on current and future train and dry port operating parameters and dry port handling volumes (see next slide);

   utilizing the Excel file “DP area and capacity calcs_BASE”
### Item 8. Design and operation of a dry port

**Case study 3**

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Input Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Current</strong></td>
</tr>
<tr>
<td>1</td>
<td>Operating days per year</td>
<td>350</td>
</tr>
<tr>
<td>2</td>
<td>Operating hours per day</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>Container train composition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- No. and length of locomotives (m)</td>
<td>1 x 22</td>
</tr>
<tr>
<td></td>
<td>- No. and length of wagons (m)</td>
<td>45 x 14.45</td>
</tr>
<tr>
<td>4</td>
<td>Container stacking height in CY</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Average dwell time in CY (days)</td>
<td>4.5</td>
</tr>
<tr>
<td>6</td>
<td>Reach-stackers working trains (No.)</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Allowance for train preparation (Hours)</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>% of containers from CY handled in CFS</td>
<td>40%</td>
</tr>
</tbody>
</table>