Design Considerations for Intermodal Container Transfer Facilities

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The Ports of Los Angeles and Long Beach were faced with the common problem of overcoming the distance and travel time between the marine container terminals and the existing intermodal rail terminals that are some 20 mi from the harbor complex. The distance and travel time meant a high transportation cost of from $70 to $100. The solution was for the ports to develop a major intermodal container transfer facility or several smaller facilities within or in close proximity to the harbor complex. A significant planning effort was undertaken to determine the most feasible type of facility, potential locations, and highway and rail access—all with the minimum possible disruption to the existing marine container terminals and general harbor traffic circulation. The preferred alternative was to construct one centrally located intermodal rail terminal that is only 4 mi from the ports. Various studies including an engineering feasibility study were conducted to determine the most efficient rail terminal layout and operational characteristics. The facility has been designed and is now under construction with an August 1986 operational date.

The Ports of Los Angeles and Long Beach are located in San Pedro Bay 20 mi or more from the rail yard terminals in the downtown Los Angeles area. The rail trackage, as does the highway network which serves the Southern California region, radiates from the central city core like the spokes of a wheel and the ports are on the perimeter. Because of this situation, each container on a through bridge movement for destinations outside the Southern California region must be trucked from the waterfront container terminals to downtown Los Angeles or to one of several recently established satellite intermodal ramps. The drayage cost of $70 to $100 per container and the 1 to 3 hr travel time required place the ports at a competitive disadvantage relative to other West Coast U.S. ports, many of which have intermodal rail terminals adjoining or in close proximity to the harbor complex.

The basic solution to the geographic problem of distance between the ports' container terminals and the rail terminals is to provide a facility or facilities within the harbor complex to perform the interchange of containers to and from rail cars. This problem and its solution have been discussed intermittently during the past 15 years by the management of both ports. However, it was not until late 1979 that a concerted effort was made to develop a major container transfer facility in the harbor area. Although the three railroads that serve Southern California have existing terminals and additional available properties on which to expand their operations in areas remote from the ports, there are no available operating properties adjoining the harbor on which new facilities could be constructed. The solution was to construct one centrally located container rail terminal open to and used by all shipping lines, provide for several subregional rail terminal facilities in the harbor complex, or modify each container terminal by installing rail trackage to permit the loading and unloading of rail cars on site.

The last alternative was reviewed and dismissed for several reasons. The configuration of most of the container terminals would not lend itself to any extensive installation of trackage. Such installation would certainly adversely affect the internal operations of the terminal. The other significant problem associated with this alternative is that there are currently 14 container terminals within the two ports. With expanded rail service to each terminal, vehicular circulation outside the terminals and in the general harbor area would be severely affected to the detriment of the entire port community.

The alternative of developing several subregional harbor rail terminals was evaluated and eliminated. Although there would be less impact on individual container terminal operations, the impact on overall vehicular circulation due to increased train and switching movements was unacceptable. Potential sites for the subregional rail terminals were reviewed and it was determined that, in general, properties with the necessary acreage and configuration did not exist or were being used for other harbor facilities and therefore were not available.

The first alternative, one large centrally located rail terminal, became the primary focus of attention. The Port of Los Angeles owned a vacant 133-acre parcel that was ideally configured for a container rail terminal. The property is approximately 7,000 ft long and 900 ft wide. It is 4 mi away and equidistant from both ports. The site has good highway access and is close to harbor-related support activities (e.g., container freight stations and transloading facilities). In addition, the port-owned property had vacant privately owned acreage on each side that could provide opportunities for expansion.

With a conceptual solution to the ports' distance problem to the existing rail terminals available, the ports' management approached the three western railroads. The initial concept was to construct a terminal that could be served by all three railroads on an equal basis. Following preliminary discussions, it became apparent that, for a variety of reasons, principally operational constraints and trackage priority assignments, this idea was not acceptable. After the initial round of discussions with the three railroads, the Southern Pacific Transportation Company indicated that they would like to have the entire facility and requested that negotiations commence on their exclusive use of the proposed terminal. At that time, Southern Pacific commanded approximately a 50 percent market share of the transportation of international marine containers through the two ports to inland U.S. destinations. Having Southern Pacific serve the proposed container transfer facility would meet the goal of having one railroad receiving marine containers in close proximity to the ports. In addition, the drayage rates to any other rail terminal in the Los Angeles area would probably be reduced to match the lower drayage charge to the new terminal.

The ports began the preparation of an engineering feasibility study for the proposed container rail terminal, named the Intermodal Container Transfer Facility (ICTF), in cooperation with the Southern Pacific. The configuration of the vacant site presented several unique opportunities that would assist the overall development of the project. The property was 7,000 ft in length, which would permit working track lengths of 5,000 ft, equal to one unit container train length. The property was vacant so that no ongoing activity had to be maintained during construction, and, because the property was not used as a rail terminal, there were no predetermined concepts about what the facility would look like or how it would be operated.

The basic items to be included in the feasibility study were

- Rail and vehicular access to the site,
- Flexibility in terminal operations,
- Container storage and spacing requirements,
- Track spacing and types of operating equipment, and
- Phasing of construction and potential expansion of the terminal.

The engineering consulting firms of Daniel, Mann, Johnson & Mendenhall (DMJM) and H.M. Scott and Associates were selected to conduct the feasibility study. Container throughput demand projections were supplied by the ports and the Southern Pacific for a period of 20 years in the future. The projections were based on actual container throughout data with a conservative extrapolation of historic trends including future expansion of container terminals in both ports and consideration of the load center concept.

The alternatives considered for container storage included remote storage (not in close proximity to the working tracks), center storage between working tracks, prestaged container storage adjoining the working tracks, and direct delivery of containers to trainside. The working track spacing analyzed included single track with loading area on one or both sides of the track, paired working tracks with a loading area on one side of each track only, and multiple working tracks with no loading areas adjoining the interior tracks.

The alternatives for operating equipment consisted of overhead straddle cranes of several interior widths; front-end loaders; side-lifting cranes; and wide, 200- to 300-ft, overhead straddle cranes. The various alternatives and optional layouts were analyzed using a set of criteria that assigned points on a scale of 1 to 100. The evaluation criteria were flexibility of operation, coordination of different operations, vehicular circulation, capital cost per unit of daily capacity, and operating cost per train unit. The cost items were somewhat judgmental and common cost items were omitted.

The various track spacing configurations, container storage methods, and types of container transfer equipment available were used to make up sets of alternatives that were analyzed. Table 1 gives a summary of the evaluation that indicates that the highest ranking alternative that provided the greatest operational flexibility was the paired working track configuration with two 40-ft-wide overhead straddle cranes per working track and center and prestaged container storage areas. A cross section of this track and storage arrangement is shown in Figure 1.

There would not be sufficient working track capacity to accommodate the projected ICTF container throughput demand past the year 2000 with only the six working tracks shown in Figure 1 if storage of containers were center and prestaged. With the doubling of projected container demand between 1985 and the year 2000, six additional tracks would have to be added to the ICTF in the future. These three additional pairs of tracks would eliminate the center storage areas. Fortunately, there are approximately 100 acres of vacant land immediately adjoining either the east or the west side of the ICTF site that can be added to the facility to compensate for the loss of the center storage areas as additional working tracks are installed. These areas can also be used to increase the overall container storage capacity of the facility. Figure 2 shows the configuration of the ultimate ICTF complex with 12 working tracks and all remote storage areas adjoining the facility.

The issues of rail and vehicular access were also addressed in the feasibility study. The Southern Pacific has a main-line track that runs from downtown Los Angeles to the harbor complex and lies approximately 300 ft from the northwestern corner of the site. Rail access to the site will be accomplished by constructing a grade separation of a state highway that lies between the main-line track and the ICTF site and making other necessary street modifications. This rail access project will permit the construction of two lead tracks with unrestricted access to the ICTF from the Southern Pacific's main-line track.

Vehicular access to the site will be from the south through two driveways. A truck entrance-exit gatehouse complex with 16 inbound-outbound lanes will be constructed for processing the necessary paperwork, container inspection, and assignment of a container parking stall or location. The entrance-exit gatehouse is set back from the street approximately 900 ft, which will permit sufficient truck storage queueing area on site. A separate driveway entrance for visitors and administrative personnel will also be provided on the south end of the project site.

The feasibility study was completed in July 1981. Since its completion, there have been several refinements to the basic project. The emergence of the extensive use of double-stack rail cars for liner train service caused a reevaluation of the working track arrangement. As a result, one working track was removed from one of the paired tracks. The remaining track will be operated with a 60-ft-wide bridge crane over the working track. This will allow sufficient trackside staging areas to off-load and load two containers on either side of the track. The other significant change was the addition of a three-high, six-wide container stacking area in one of the center storage areas. The most efficient mode of operation is an all-wheeled system (i.e., all containers on chassis). However, discussions with several of the potential users of the ICTF indicated that their own chassis requirements would not allow the container to stay on the chassis in the ICTF for any period of time or that their chassis may not be immediately available for inbound containers. As a result, consideration will have to be given to a

TABLE 1 Comparison of Equipment and Operating Alternatives

									Ratings							
Alternative	Operating Concept	Handling Equipment per Track	Handlings per Container Train	Train Unload/ Load Time (hr)	Facility Track Capacity	Number of Trains per 8-hr Shift	Capital Cost per 8-hr Shift Train Capacity[a] (10^6 $)	Operating Cost per Train ($)[a]	Capacity[b]	Flexi-bility	Coordi-nation Require-ments	Accommo-date 2-Way Traffic and Units	Capital Cost	Operating Cost	Total Score	Rank
I-A	PDS, CDS,	2 40-ft BC	DS-230	3.83	10	13.7	DS-1.80	DS-1,250	83.3	100	50	100	83.9	81.7	498.9	4
	PRS, CRS		RS-460				RS-2.13	RS-3,020					70.7	47.4	451.4	12
I-B	PDS, CDS,	2 60-ft BC	RS-460	3.83	8	11.0	DS-2.13	DS-1,320	66.7	100	50	100	70.7	76.7	464.1	11
	PRS, CRS						RS-2.45	RS-3,090					57.8	44.3	418.8	19
I-C	PDS, CDS,	2 40-ft BC	RS-460	3.83	15	20.6	DS-1.40	DS-1,080	100.0	100	50	100	100.0	96.7	546.7	2
	PDS, CRS						RS-1.73	RS-2,840					86.7	55.3	492.0	6
II-A	CDS	2 40-ft BC	RS-460	3.83	19	26.1	DS-1.41	DS-1,080	100.0	50	0	25	99.6	96.7	371.3	24
	CRS						RS-2.39	RS-2,850					60.2	54.8	290.0	31
II-B	CDS	2 40-ft BC	RS-460	3.83	20	27.4	DS-1.32	DS-1,040	100.0	50	0	25	100.0	100.0	375.0	23
	CRS						RS-1.64	RS-2,800					94.4	57.0	322.4	28
III-A	PDS, CDS,	2 FEL	RS-460	4.79	7	8.25	DS-3.49	DS-2,240	47.6	100	50	100	16.1	0	313.7	29
	PRS, CRS						RS-3.80	RS-4,100					3.6	0	301.2	30
III-B	PDS, CDS,	2 FEL	RS-460	4.79	13	15.3	DS-2.28	DS-1,700	86.7	100	50	100	64.7	45.0	446.4	13
	PRS, CRS						RS-2.58	RS-3,560					52.6	23.7	413.0	20
IV-A	PCS	2 FEL	230	4.79	5	5.9	CS-3.89	CS-2,435	33.4	25	100	100	0	73.0	331.4	27
IV-B	PCS	2 FEL	230	4.79	9	10.6	CS-2.60	CS-1,860	60.0	25	100	100	51.8	98.2	435.0	16
V-A	PCS	2 FEL	230	4.79	4	5.5	CS-3.72	CS-2,410	26.7	25	100	100	6.8	74.1	322.6	26
V-B	PCS	2 FEL	230	4.79	8	11.1	CS-2.46	CS-1,820	53.3	25	100	100	57.4	100.0	435.7	15
VI-A	PDS, CDS,	2 FEL	DS-230	4.79	13	17.9	DS-1.93	DS-1,600	86.7	100	50	50	78.7	53.3	418.9	18
	PRS, CRS		RS-460				RS-2.19	RS-3,460					68.3	28.1	383.1	22
VI-B	PRS, CDS,	2 FEL	RS-460	4.79	22	30.4	DS-1.48	DS-1,400	100.0	100	50	50	96.8	70.0	466.8	9
	PRS, CRS						RS-1.74	RS-3,600					86.3	36.8	423.1	17
VII	PCS	2 80-ft BC	230	3.84	9[c]	18.8	CS-1.55	CS-2,930	75.0	25	100	0	94.0	51.3	345.3	25
VIII-A	PDS, CDS,	2 SP	DS-230	3.84	7	11.5	DS-2.20	DS-1,450	58.3	100	50	100	67.9	65.8	442.0	14
	PRS, CRS		RS-430				RS-2.48	RS-3,220					56.6	38.6	403.5	21
VIII-B	PDS, CDS,	2 SP	RS-430	3.84	14	23.0	DS-1.52	DS-1,150	100.0	100	50	100	95.2	90.8	536.0	3
	PRS, CRS						RS-1.79	RS-2,910					84.3	52.2	486.5	7
I-C MOD	PDS, CDS,	2 40-ft BC	RS-460	3.83	12	19.9	DS-1.21	DS-1,050	100.0	100	50	100	98.9	99.2	548.1	1
	PRS, CRS						RS-1.48	RS-2,820				126	88.9	56.1	495.0	5
IV-B MOD	CDS, CRS	2 40-ft BC	CS-460	3.83	10	16.6	DS-1.18	DS-1,055	83.3	75	25	100	100.0	93.8	482.1	8
	PCS						CS-1.45	CS-1,985					90.0	92.8	466.1	10

Note: Costs listed in this table are incomplete; they include differential elements among alternatives and exclude common components. PDS = pretrain direct staging, CDS = coordinated direct staging, PRS = pretrain remote staging, CRS = coordinated remote staging, PCS = pretrain center storage and staging, DS = direct staging, RS = remote storage, CS = center storage and staging, BC = bridge crane, FEL = front-end/bottom loader, SP = super packer cantilever crane.

[a] Remote storage concept cost does not include costs of remote storage facilities and operations.

[b] Year 2000 demand requires 12 tracks with BCs or 15 tracks with FELs.

[c] Actually 27 tracks are installed, but only one of every three can be worked at a time unless additional BCs are added, which requires too much equipment and causes congestion.

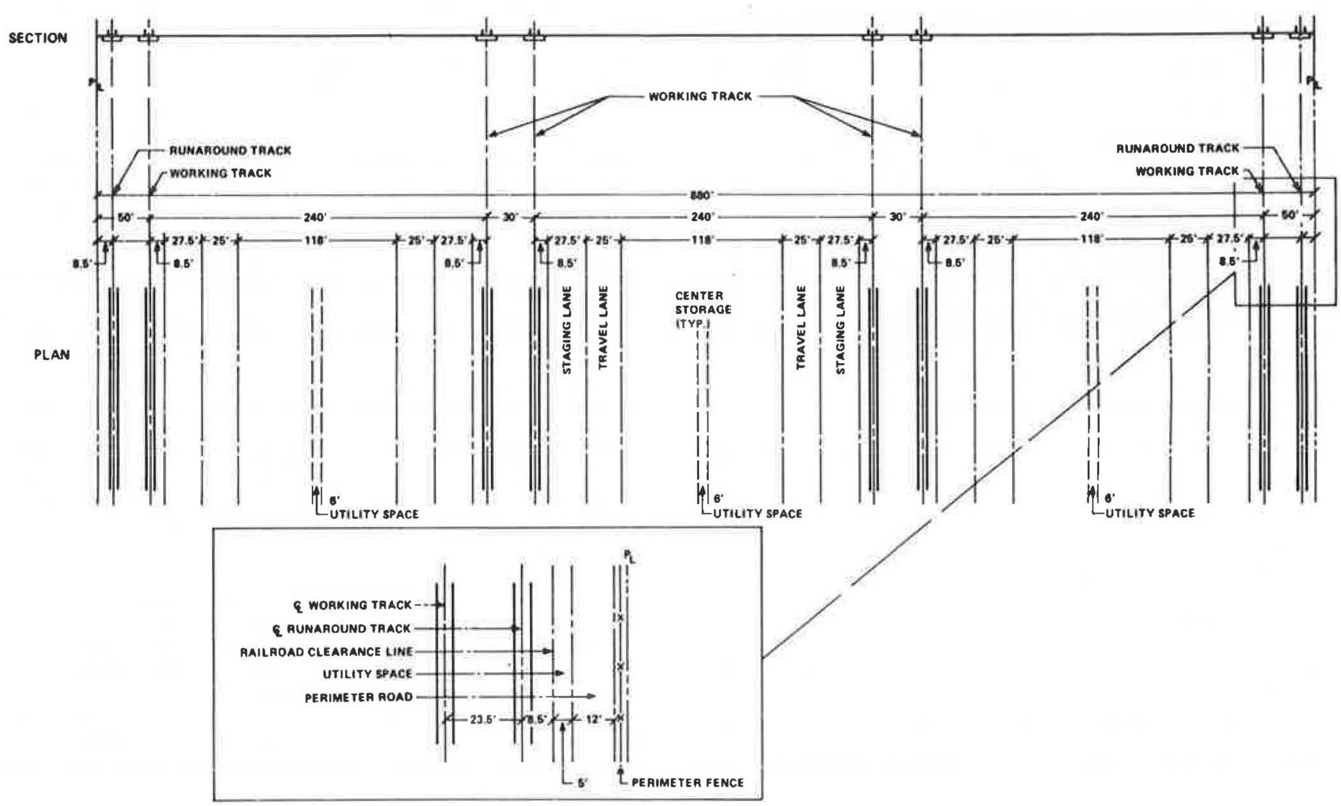

FIGURE 1 Intermodal transfer area—arrangement for center storage.

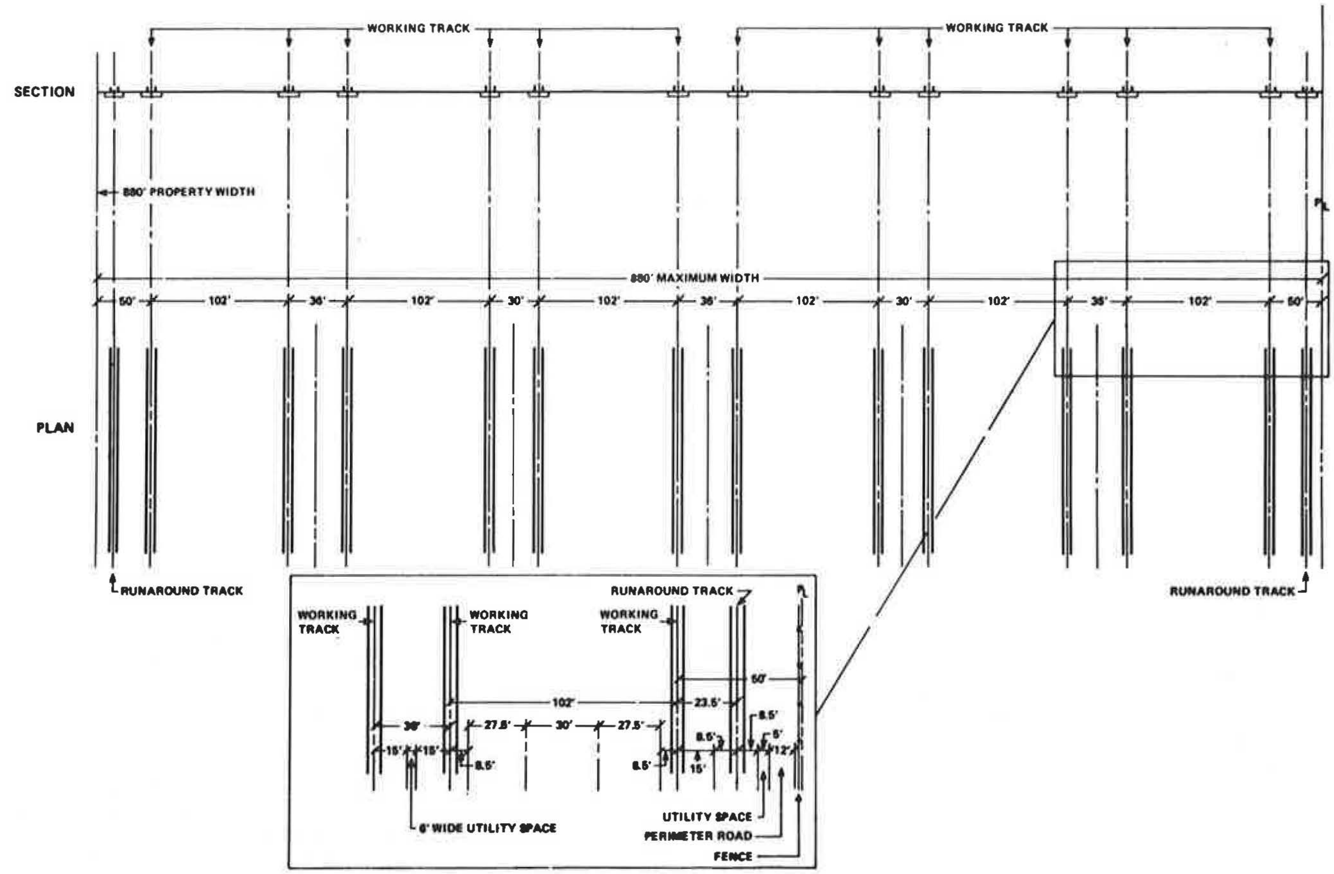

FIGURE 2 Intermodal transfer area—arrangement for remote storage.

pool of yard chassis or the container will have to be stored in a stack area.

Using the paired working track configuration and initially the center storage concept with ultimately added adjoining remote container storage, a three-phase facility was designed to accommodate increases in container throughput. Phase 1 construction includes track spacing based on the Figure 1 track arrangement, all the necessary utilities, substructures, buildings, pavement, and yard lighting. A unique design feature of the utilities systems is that they are designed for the maximum number of required working tracks in terms of location and capacity. Phase 1 is a complete facility with all support functions provided.

Phase 2 of the ICTF project would add one pair of working tracks in one of the center storage areas and approximately 40 acres of adjoining property for remote storage. This 40-acre parcel is a power line right-of-way and the storage of containers on chassis is a permitted use of space under power lines. In addition, the container-stacking area within the facility would be expanded. The Phase 3 project, as presently planned, includes the installation of three additional working tracks: one set of paired working tracks and one track adjoining the single track where the double-stack rail cars are to be loaded. Approximately 50 acres of property would be added to the facility in Phase 3 to replace the loss of container storage in the center storage areas.

Before the installation of additional trackage in either of the future phases, the efficiency of loading and unloading double-stack rail cars will be reexamined. Although the double-stack cars can be worked on either a single track with access to both sides of the rail car or on a paired track arrangement with access to only one side of the rail car, the single-track method is more efficient. The use of double-stack rail cars presents its own operational considerations that must be addressed. The double-stack car does double the rail car spot capacity within a terminal and changes both the requirements for container storage capacity and the number of chassis available within the yard or from the shipping line.

Phase 1 of the ICTF has an effective annual capacity of 360,000 container units. Phase 2 increases the annual capacity to 500,000 units and, if Phase 3 is constructed, the ultimate throughput capacity will exceed 700,000 container units. The container units are 40-ft-equivalent units.

The ICTF project as designed has the flexibility necessary to allow expansion in the future to handle increases in container throughput demand and potential changes in railroad equipment and operating lift equipment. Track capacity and container storage capacity can be increased together or separately as changes occur in the marketplace, such as new requirements of the steamship lines or dómestic shippers using international marine containers for the movement of cargo on the westbound move.

The contract for the the construction of the Phase 1 ICTF project was awarded August 1, 1985, and, on a 1-year construction schedule, the facility will be operational in late August 1986.