

Shunting Operation Plan for the Freight Trains

Fei Wang

Southwest Jiaotong University Hope College, Chengdu 610400, China.

Abstract: This paper proposes an optimal shunting operation of a train stock waiting to be broken up and made up according to each carriage's destination. The shunting operation includes breaking up and make-up shunting, using a shunting list to make the plans. Processes including dropping down, adjustment and merging train stock are helpful when making the shunting list. Shunting trip, shunting distance and shunting working time are the index when comparing different plans.

Keywords: Shunting; Shunting Trip; Shunting Distance

1. Shunting Relevant Theories

Shunting

In the production processes of railway transportation, shunting operation is the moving of locomotives, train stocks and carriages within the train station. Shunting operation is one of the basic contents of railway work. Shunting operation can be divided into the following types according to different purposes.^[1]

1) Break-up shunting: decompose the arriving train or train stocks into designed lines based on each carriage's destination, purpose or types.

2) Make-up shunting: according to regulations and train composition plan requirements, select carriages and attach them into train stocks.

3) Detaching and attaching of wagons shunting: add or reduce train weight, or exchange carriages.

4) Taking-out and placing-in of wagons shunting: send or retrieving carriage or train stocks from loading and unloading lines, maintenance line and shunting lines.

5) Other shunting: line transfer, yard transfer or arrange shunting yard etc.

Shunting trip

Shunting trip is work of coupling or uncoupling a carriage or train stock. There are two shunting trips: one is the wagon coupling trip, and the number of the train stock will increase in the shunting operation. The other is wagon uncoupling trip, and the number of the train stock will decrease in the shunting operation.^[2]

Shunting distance

A shunting distance can be divided into one or more shunting trips. Shunting distance means the moving of locomotive, train stock or carriages with purposes, and usually not change the direction. Although in one shunting distance the direction is not changed, the moving can belong to different shunting distances.^[3]

In most cases, a wagon coupling trip equals two shunting distances. Because the locomotive shall move from hump to the Reception-Departure yard, and hang at the end of the train stock stopping in the Reception-Departure yard before being pushed to the hump. In the whole process of wagon coupling, the direction is changed.

As for the wagon uncoupling trip, one shunting trip just equals one shunting distance as in the operation of breaking up, the distance is not changed.

2. Case Study

Train stock 456351243653147 (the number means the destinations.) stops in shunting yard line 7, waiting for detached and attaching of wagons shunting operation according to the order of arrival of stations (the final order of train stock is 1234567). The shunting locomotive

works on the right of the train stock and pulls out all carriages at a time. There are only four shunting lines (line 7, 8, 9 and 10) allowed to use, and the train stock will prepare in line 3 waiting for departing.

2.1 Drop Down

Drop down is the preparation of the detached and attaching of wagons shunting work, which is to break up the carriages into different shunting lines.

The specific ways are that, beginning with the left of the shunting list, to find out the first carriage “1”, and write down in the first row. Then, find all the “1” carriages at the right hand of the first “1”. If there is no more “1”, find out the carriage “2” and write down in the first row. And so on, until all the carriages are dropped down in the shunting list.

In short, in each row, the order of the numbers from left to right is from small to large, like 112, 1223, rather than 121.

The result of dropping down Train stock 456351243653147 is shown in Form 1 Shunting List – Drop Down, which using 5 rows.

Form 1 - Shunting List – Drop Down

Train Stock Row Line	4	5	6	3	5	1	2	4	3	6	5	3	1	4	7
A						1							1		
B							2		3			3			
C				3				4						4	
D		4	5		5						5				
E				6						6					7

2.2 Adjustment

Some train stocks can be dropped down in more than one row, and these train stocks are called as “Adjustable Train Stocks”.

In the case study, the first carriage “1” is an “Adjustable Train Stocks”, because it can be dropped down in both Row A and Row B. If the first carriage “1” is dropped down in the second Row, Row B will be shown as “1233”, which is also in the right order.

However, we should take the shunting trip into consideration when drop “Adjustable Train Stocks” down. If the carriage is dropped in Row A, it cost two wagon uncoupling trips for carriage “1” and the following carriage “2”. But if the first carriage “1” is dropped in Row B, it only cost one wagon uncoupling trip to pull out carriage “1” and carriage “2” because they are coupled together. Therefore, the shunting list with adjustment is in Form 2- Shunting List – Adjustment.

Form 2 - Shunting List – Adjustment

Train Stock Row Line	4	5	6	3	5	1	2	4	3	6	5	3	1	4	7
A						1							1		
B						1	2		3			3			
C				3				4						4	
D		4	5		5						5				
E				6						6					7

2.3 Mergence

Each row in the shunting list means a shunting line. From the result of Form 2, the train stocks occupy 5 rows after dropping down and adjustment, which means the shunting work shall use 5 shunting lines. However, the train station only provides 4 shunting lines for this detached and attaching of wagons shunting operation, so the 5 rows in the shunting list should be merged into 4 rows.

There are many ways to merge the row, like combining Row B and Row D, Row B and Row E, Row C and Row E etc. All ways are practicable, but there shall be an optimal solution, which costs the least shunting trip and the least shunt working time.

3. Shunting Plans Comparison

3.1 Plan 1

Combine Row B and Row D, then train stocks in Row B will be dropped as “45512353”, which forms a temporarily merged train

stock. And the way to break up the temporarily merged train stock, shunting locomotive shall put these stocks and detach again.

Train stock 456351243653147 stops in line 7, and the first two carriages which shall be break up first are dropped in Row B. In order to save shunting trip, set Row B as line 7, and the other 4 rows are line 8, 9 and 10 respectively (Form 3- Shunting List – Plan 1).

Shunting operation of Plan 1 is in Picture 1 – Shunting Operation. (CF3 means “Chu Fa Chang”, also called as the departure yard.)

Form 3 - Shunting List – Plan 1

Train Stock Row Line	4	5	6	3	5	1	2	4	3	6	5	3	1	4	7
A	8												1		
B	7	4	5		5	1	2		3		5	3			
C	9			3				4						4	
D		4	5		5						5				
E	10			6						6					7

3.2 Plan 2

Combine Row B and Row E, then train stocks in Row B will be dropped as “6123637”, which forms a temporarily merged train stock. And the way to break up this temporarily merged train stock, shunting locomotive shall put these stocks and detach again.

Train stock 456351243653147 stops in line 7, and the first two carriages which shall be break up first are dropped in Row D. In order to save shunting trip, set Row D as line 7, and the other 4 rows are line 8, 9 and 10 respectively (Form 4- Shunting List – Plan 2).

Shunting operation of Plan 1 is in Picture 1 – Shunting Operation.

Form 4 - Shunting List – Plan 2

Train Stock Row Line	4	5	6	3	5	1	2	4	3	6	5	3	1	4	7
A	8												1		
B	9		6			1	2		3	6		3			7
C	10			3				4						4	
D	7	4	5		5						5				
E			6							6					7

3.3 Plan 3

Combine Row C and Row E, then train stocks in Row B will be dropped as “634647”, which forms a temporarily merged train stock. And the way to break up this temporarily merged train stock, shunting locomotive shall put these stocks and detach again.

Train stock 456351243653147 stops in line 7, and the first two carriages which shall be break up first are dropped in Row D. In order to save shunting trip, set Row D as line 7, and the other 4 rows are line 8, 9 and 10 respectively (Form 4- Shunting List – Plan3).

Shunting operation of Plan 1 is in Picture 1 – Shunting Operation.

Form 5 - Shunting List – Plan 3

Train Stock Row Line	4	5	6	3	5	1	2	4	3	6	5	3	1	4	7
A	8												1		
B	9					1	2		3			3			
C	10		6	3				4		6				4	7
D	7	4	5		5						5				
E			6							6					7

3.4 Plan 4

Combine Row C and Row E, then train stocks in Row B will be dropped as “4565657”, which forms a temporarily merged train stock. And the way to break up this temporarily merged train stock, shunting locomotive shall put these stocks and detach again.

Train stock 456351243653147 stops in line 7, and the first three carriages which shall be break up first are dropped in Row D. In order

to save shunting trip, set Row D as line 7, and the other 4 rows are line 8, 9 and 10 respectively (Form 4- Shunting List – Plan 4).

Shunting operation of Plan 1 is in Picture 1 – Shunting Operation.

Form 6 - Shunting List – Plan 4

Train Stock Row Line	4	5	6	3	5	1	2	4	3	6	5	3	1	4	7
A	8												1		
B	9					1	2		3			3			
C	10				3			4						4	
D	7	4	5	6		5				6	5				7
E				6						6					7

Plan 1	Plan 2	Plan 3	Plan 4
7+13	7+13	7+13	7+12
10-1	9-1	10-2	10-1
9-1	10-1	7-1	7-1
7-3	7-1	9-2	9-2
9-1	9-2	10-1	10-1
7-1	10-1	9-1	9-1
10-1	9-2	10-1	7-2
7-2	7-1	7-1	9-1
8-1	9-1	9-1	8-1
9-1	8-1	8-1	10-1
7+8	10-1	10+4	7+6
9-3	9+6	7-1	10-2
8-3	7-1	9-2	7-1
9-1	8-3	7-1	10-1
8-1	7-1	9-1	7-1
10+2	8-1	7+6	10-1
9+7	7+6	9+7	7+2
8+5	10+3	8+1	10+7
CF3-15	8+5	CF3-15	9+4
	CF3-15		8+1
			CF3-15

Picture 1 – Shunting Operation

3.5 Summarise of 4 Shunting Plans

For Plan 1, it costs 5 wagon coupling trips, and 13 wagon uncoupling trips (not include the last shunting trip, which pushing off the made-up train stock into the detaching yard). According to the required minutes per trip, a wagon coupling trip costs 4 minutes, and a wagon uncoupling trip costs 1 minute. Therefore, Plan 1 needs 23 shunting distances and 33 minutes in total.

As for Plan 2, it costs 5 wagon coupling trips, and 14 wagon uncoupling trips (not include the last shunting trip, which pushing off the made-up train stock into the detaching yard). Therefore, Plan 2 needs 24 shunting distances and 34 minutes in total.

As for Plan 3, it costs 5 wagon coupling trips, and 13 wagon uncoupling trips (not include the last shunting trip, which pushing off the made-up train stock into the detaching yard). Therefore, Plan 2 needs 23 shunting distances and 33 minutes in total.

As for Plan 4, it costs 6 wagon coupling trips, and 14 wagon uncoupling trips (not include the last shunting trip, which pushing off the made-up train stock into the detaching yard). Therefore, Plan 2 needs 26 shunting distances and 38 minutes in total.

Compared to the 4 plans, Plan 1 and Plan 3 are the optimal ones.

4. Conclusion

In the case study and shunting plan analysis, there are two optimal ways for the train stock to operate. Both of the two ways occupy 4 shunting lines, 23 shunting trips and 33 shunting distances.

However, not all feasible shunting ways are considered in the study, and in the practical shunting work of train station, how many

available shunting lines can be used is based on the situation of shunting yard and shunting locomotives.

A shunting operation using least shunting lines but not the least shunting trip uncertain. Therefore. It needs the staff with rich experience and close cooperation among various departments to improve efficiency.

References

[1] <https://baike.so.com/doc/7853436-8127531.html>

[2] Peng Qiyuan, Wang Ciguang, Organisation of Train Operation, Chapter 1, The Theory and Methods of Shunting Work, 2006, p:29.

[3] Peng Qiyuan, Wang Ciguang, Organisation of Train Operation, Chapter 1, The Theory and Methods of Shunting Work, 2006, p:30.