CHAPTER 3
DEPARTURE DELAY ANALYSIS

3.1 Introduction

River pilots of ships with drafts in the 38- to 40-ft range must schedule their departures to meet underkeel clearance requirements within the Columbia River channel and at the mouth. This can require ships to delay their departure from upriver ports for several hours after they have finished loading to wait for favorable tide conditions. The length of a delay depends on the ship's draft, river discharge, tide stages, and controlling depths in the channel.

3.2 Operating Practices

Ship transits on the Columbia River are governed by a number of standard operating practices that are influences by the pilots, vessel type, tide stages, wave conditions, controlling depths, and government regulators. While there have been exceptions to any and all of the following practices, the standard operating practices for the Columbia River are described below.

The designated 40-ft depth of the navigation channel is based on a low-low-water, water surface profile referred to as the Columbia River Datum (CRD). The actual depth of water available in the channel during any given transit depends on the combination of tide, river discharge and controlling depths. Each of those parameters is constantly changing, with tide stage being the critical factor on a day-to-day basis. By taking advantage of tide stages that are frequently 1- to 2-ft or more above 0 CRD and controlling depths greater than 40 ft, a ship may be able to transit with a minimum water depth of 42 to 45 ft.

Underkeel clearance is the critical factor for determining the departure draft of a ship transiting the river channel. Underkeel clearance changes constantly as a ship moves through the river because of the changing river stages and sand waves on the bottom of the channel. Minimum underkeel clearance generally occurs within a short reach of channel near the point of minimum river stage. Because of the limited duration of the condition, minimum underkeel clearances are quite small in the Columbia River. As explained in Chapter 1 of this Appendix, bulk carriers drawing 40 ft are willing to transit with a minimum underkeel clearance of 0 ft, while container ships prefer a minimum of 2 ft.

Tide and wave conditions at MCR also influence operating practices. The Bar Pilots standard practice is for a ship to have a minimum of 3 ft of underkeel clearance on a rising tide or 4 ft on a falling tide. This means that the river pilots of 39-40 ft draft ships must schedule their arrival in Astoria to fall within one of the two daily tide windows for MCR departure, as well as meet underkeel requirements in the river channel. High waves are not usually a factor in departure scheduling. However, waves in the range of 18-20 ft or higher, will close MCR to all ships.

The above minimum values for underkeel clearance and water depth available in the Columbia River would occasionally allow maximum drafts of 43 ft for bulk carriers and 42 ft for container ships. However, regulatory pressure from the Oregon Board of Maritime Pilots limits the maximum draft in the river to 40 ft.

These standard operating practices provide the basis for the delay times presented in the following sections. The expected delay for any given ship could be minimized by agreement between the shipper, and river and bar pilots to work outside of the standard practices.

3.3 MCR Delays

The Bar Pilots guideline is for a ship to have 3 ft of underkeel clearance on a rising tide or 4 ft on a falling tide. This means that 39-40 ft draft ships have two tide windows through which to depart MCR. How closely this is followed depends on the individual pilot and the channel conditions at the time of departure. However, because it is the most likely operating practice, that guideline was used to determine the potential delay times that could be attributed to MCR.

The following steps were followed to calculated delay times.

1. The controlling depth was assumed to be 40 ft CRD for the existing channel and 43-ft for the new channel.
2. The required tide stage was determined for the selected drafts.
3. The percent of the time that river stages would be below the required stage was determined from a stage duration curve for 1991-1993.
4. The total time during a tide cycle when stages were below the required level were divided into two equal periods.
5. Delays could range from 0 to 100 percent of a delay period, and would average 50 percent.
6. Since ships could be ready to depart from port at any time, the probability of a delay would equal the percent of time the tide stages were below the required level.
7. The average delay per Columbia River transit would then be equal to the average delay time multiplied by the probability of being delayed.

Draft in		Available				
40-ft Chan.	43-ft Chan.	Transit Time per Tide Cycle	Delay Time per Tide Cycle	Avg. Time per Delay	Probability of Delay	Avg. Delay per Ship
40 ft	43 ft	13.6 hrs	11.2 hrs	2.8 hrs	45%	1.3 hrs
39 ft	42 ft	16.4 hrs	8.4 hrs	2.1 hrs	34%	0.7 hrs
38 ft	41 ft	20.0 hrs	4.8 hrs	1.2 hrs	19%	0.2 hrs

3.4 River Delays

In order to meet the Bar Pilots requirements at MCR, ships must pass through a low tide somewhere within the river channel. The river pilot can adjust departure time to sail through that low tide at a location with sufficient controlling depth to maintain an acceptable amount of underkeel clearance and still meet the bar pilot's requirements.

The following delays are based on work done by Ogden Beeman and Associates in 1994 for the Port of Portland. Departure drafts have been adjusted from the Beeman work to account for the different minimum underkeel clearance requirements of bulk carriers and container ships.

Container Ships

Draft in		Probability of Delay by Time Increment				Average
		Time Increment of Delay				Delay
40-ft Chan.	43-ft Chan.	0 hrs.	0-6 hrs.	6-12 hrs.	12-24 hrs.	Per Transit
40 ft	43 ft	44%	25%	14%	17%	5.1 hrs.
39 ft	42 ft	73%	21%	6%	0%	1.2 hrs.
38 ft	41 ft	100%				0 hrs.

Bulk Carriers

Draft in		Probability of Delay by Time Increment				Average
		Time Increment of Delay				Delay
40-ft Chan.	43-ft Chan.	0 hrs.	0-6 hrs.	6-12 hrs.	12-24 hrs.	Per Transit
41 ft	44 ft	44%	25%	14%	17%	5.1 hrs.
40 ft	43 ft	73%	21%	6%	0%	1.2 hrs.
39 ft	42 ft	100%				0 hrs.

The delays for MCR and the river are not additive because the river delays are scheduled to meet the MCR sailing windows. The delay that a ship would experience would be the longer of the MCR or river delays.