Petrack

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PRELIMINARY MATERIAL ON PROCESS CONTROL COMPUTER SOFTWARE FUNCTIONS

A. INTRODUCTION

This note is to record some of the findings regarding the functions of the process control computer (PCC) in a hump yard. This material, which will be further improved and modified by future informal notes, will serve as input to Sections II-C and IV of the handbook on terminal computers as specified in Informal Note #54.

The functions of PCC in a hump yard may be categorized by two points of view: (1) From geographical area of the yard, or (2) from the nature of the function. Geographically, the PCC function may be divided into the following areas:

1. Pre-crest (from receiving yard to the crest)
2. Crest
3. Crest-to-Master Retarder
4. Master Retarder-to-Group Retarder
5. Group Retarder-to-Tangent Retarder
6. Tangent Retarder-to-Coupling point
7. Pullout end and departure yard.

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From a functional point-of-view the purpose of the PCC may be listed as follows:

1. Surveillance and measurement
2. Automatic routing and switch control
3. Speed control
4. Engine dispatch and control
5. Car and track inventory
6. Safety, including area and track protection
7. Collecting MIS data for the MIS function.

In this and subsequent informal notes, the material will be organized in order of yard geography. Only three areas will be presented in this note--pre-crest, crest, and crest-to-master retarder. At this point, each function is described as an independent event. Later on, relations for both control flows and data flows among various software routines will be presented in flow diagram forms.

B. PRE-CREST CONTROL

1. General

This function covers the processing of advanced consists (the portion that is relevant to the PCC function) to the automatic lining up of the switches from receiving tracks to the hump approach. It is in this function that the arrival train information and certain operational management decisions (e.g., the classification table, the hump list) are handed off from the MIS computer to the PCC. Also, it is in this process that the advanced consist information is successively purified and enhanced with the progression of time as more factual train data are transmitted to the yard prior to train arrivals. Finally, the train and car data should be 100% accurate before the development of the hump and pin-puller's lists since ACI reading and receiving inspection tasks will correct any last minute discrepancies that have existed between the train consist and the physical inventory.

While the inventory data of the receiving area are being verified and corrected, the operational management decision function of the MIS system is generating track assignment decisions based on pre-established criteria, classification tables, decision rules, and the current and predicted track utilization of the yard. The track assignment determination is a necessary step for generating hump switch list, pin-puller's cut list, and the routing sequence from the receiving tracks to the hump. It is at this time that the process control function takes over from the MIS function. The PCC will perform automatic routing from receiving to hump and maintains pre-crest car inventory.

2. Routine for Automatic Routing from Receiving to Crest

a. Input:
   (1) Receiving track inventory
   (2) Hump list
   (3) Track assignment list
   (4) Current switch settings

b. Output: Command to align receiving yard switches for the next batch of cars heading for the hump.

c. Processing: This routine is to line up the switches in order to move the next batch of cars from the receiving tracks to the hump in accordance with humping sequence.

3. Receiving Yard Inventory Routine

a. Input: (1) Train consists

(2) ACI data

(3) Receiving inspection report

b. Output: Car I.D. by track and by position to be maintained in the PCC on-line file.

c. Processing: This function can either be performed by the MIS computer, or the PCC, or both. If automatic routing from receiving to the crest is to be done by the PCC then it is a requisite that the PCC has on-line access to the inventory file by car, by track, and by position.

C. CREST CONTROL

1. General

The crest control function extends from the receiving leads through the crest. Its main function is to ascertain humping sequence, effect accurate pin pulling, measure and control hump speed, control and verify proper routing, initiate corrective actions when necessary, and so forth.

2. Route and Engine Control

a. Input: (1) Switch alignment settings from receiving to crest.

(2) Hump speed instruction from dynamic speed control calculation or from a pre-determined average speed.

(3) Current hump signal status from the hump approach track circuit.

(4) Automatic routing plan as generated by pre-crest control.

b. Output: (1) Go or no-go signal to hump shove lights

(2) Speed category number to shove lights

(3) Speed control command to cab

c. Processing: This software routine is to ascertain that the route switches from receiving to hump approach are aligned properly in accordance with the automatic routing plan generated by pre-crest control route selection software. The control signal is sent out in one or more of the following ways:

(1) Go or no-go signal to the hump shove light. This is the simplest form of control command.

(2) Simple speed control instruction to the shove lights, for example, stop (red), fast (green), or slow (amber).

(3) In a more automated system, the speed control instruction goes directly into the cab engine control.

3. <u>Determining Optimal Hump Speed</u>

a. Input: (1) Desired yard throughput parameters

(2) Penalty factors (as a function of the routing and attributes of the cut) in case of misrouting due to catch-ups

b. Output: Speed control instructions to hump engine

c. Processing: This routine helps to maximize the throughput of the yard by assigning the highest hump speed feasible; yet at the same time it must minimize the probability of misroutes due to car catch-ups. The cost of correcting misroutes often negates the intended throughput gain. The determination of hump speed is dependent upon the route pattern selected (distance between switches, track layout, etc.), the tag number of the cut (e.g., if the current cut goes to the same class track as the previous cut then it is not too critical if the two cuts are relatively close to each other), and many other speed control and rollability considerations to be determined with inputs from other parts of the yard.

4. Generation of Pin Puller List

a. Input: (1) Track assignment list

(2) Hump switch list

(3) Post-humping surveillance feedback

b. Output: Pin-puller's list (statistic) or CRT display (dynamic).

c. Processing: From the hump switch list and track assignment instructions (an operational management decision under the MIS function) a cut list is developed. A cut is determined by the common destination of contiguous cars and the upper limit on the number of cars allowed in a cut. The pin-puller's list is traditionally in hard copy form with annotations and modifications written in. In a more dynamic system the pin-puller's list is a CRT display and the system can accept last minute changes or error corrections as long as the cars in question have not passed the pin-puller. The cars that are not to be humped (but will be re-routed) are also displayed.

5. Hump Wheel Detector Input Processing

a. Input: (1) Signals representing passage of axle over each sensor

(2) Time of each passage

b. Output: (1) Net count for each wheel detector

(2) Net car count by direction

(3) Passage time of each set of the axles

c. Processing: The sensing of axle passage over the wheel detectors will generate a priority interrupt to the PCC. The computation of axle count involves the time of passage of each axle and the elapsed times between axle passage times, as well as the correlation of passage data between wheel detectors. Usually two sets of detectors are placed at the crest to enhance computation (particularly in a bi-directional movement situation) and provide redundancy checks.

6. Hump Speed Calculation

a. Input: Data from hump wheel detector processing routine

b. Output: Current hump speed

c. Processing: This routine is to compute hump speed based on the passage times of the first and second axles and the assumed length between axles. Conceptually, the hump speed (in feet per second) is the difference between the two axle passage times (in seconds) divided into the wheel base (in feet).

7. Hump Operation Display

a. Input: (1) Data from hump speed wheel detector processing routine

(2) Hump list

b. Output: (1) Updated "as humped" list

(2) CRT display

c. Processing: The hump wheel detector process routine gives confirmation that a car has passed the crest. This information is used in conjunction with the hump list to establish the identification of the car which has just been humped. As each car passes the wheel detectors its car I.D. is removed from the top of the CRT display, and the whole CRT page will move up one line. The purpose of the display is to give visual verification of the accuracy of the on-line record. A mistake may occur if the wheel detection routine miscounted the axles, or if the hump list is out of sequence in relation with the physical order of the cars. The cars that passed the visual verification will go into the "as humped" file.

8. Switch Alignment for Front-end Trim Operation

a. Input: (1) Instruction from hump supervisor's console

(2) Computer flags indicating blocked or locked areas

b. Output: Control signals to align switches for an area between the crest and a track.

c. Processing: There are occasions when the hump engine is asked to perform trim operation at the front end of the yard (from the crest to class tracks), for example, for the purpose of re-humping. The instruction for front-end trim comes from the hump supervisor, and the switch alignment is done automatically for an area provided the trim operation will not be in conflict with another protected or blocked area at the time. When the trim operation is completed, the hump supervisor releases the area lock and the switches will then again be given back to automatic routing control.

9. Area Trim Protection

a. Input: Instructions from yard master or area supervisor via on-line console

b. Output: Switch alignment instructions for locking all switches leading into the trim area for area protection. The switches within the trim areas are released from automatic control and turned over to area supervisors for local control.

c. Processing: Requests may come from the yard master or area supervisor via on-line computer terminals for performing trim operation in an area (defined by tracks, leads, frogs, etc.). This routine identifies all the switches leading into the defined area and locks them out from external control until a release command is issued. During the time of the area lock, the area is not accessible to automatic routing or humping. The control is given to the area supervisor or foreman for local manual or semi-automatic control. The significance of the area lock to the humping operation is that the locked tracks may cause some cars to be re-routed to slough tracks.

D. CREST-TO-MASTER RETARDER

1. General

The main purpose of this post-crest process control function is to check and verify pin-puller's action, collect car velocity and other physical data for speed control, and update car inventory. This function is aided by wheel detectors, photo cells, radars, and weigh scales and so forth.

2. Post-crest Wheel Detector Processing

a. Input: Signals from wheel detectors (placed between the crest and the master retarder) indicating the passage of an axle. The input comes into the computer on a priority interrupt mode.

b. Output: (1) Cummulative axle counts for each detector

(2) Passage time of each axle

c. Processing: This is a front-end processing routine to reduce wheel passages and passage times to axle counts and length between axles [based on a measured (or assumed) speed]. In order to enhance detection reliability, usually 2 sets of wheel detectors are installed (between the crest and the master retarder). This information will be compared with photo cell and radar data for validity check.

3. <u>Photo Cell Detection Routine</u>

a. Input: (1) Photo cell beam contact change creates an interrupt to the PCC.

(2) Hump list

b. Output: (1) The determination of the beginning and end of a cut and the sending of signal to radar unit to turn on and off radar doppler pulse accumulator for car length measurement

(2) Cut passage times (both front and end).

(3) Car height category

c. Processing: The photo cell detects the beginning and the end of a cut (the coupling joints constitute a continued state). The passage times of the front and end of a cut will help to verify wheel detector data and enhance identification of car inventory between the crest and the master retarder. The photo cell signal also is used to turn on and off radar doppler pulse accumulator for car length measurement.

Another function of the photo cell sensor is to detect the height of cars for rollability measurement.

4. Radar Detection of Cut Length

   a. Input: Radar pulse return

   b. Output: Cut length measurement

   c. Processing: The radar doppler pulse accumulator is turned on and off by photo cell's detection routine. Cut length data are calculated and used for speed control and car identification.

5. Determination of Car Axle Count

   a. Input: (1) Wheel detector routine information

      (2) Photo cell routine information

      (3) Radar routine information

   b. Output: (1) Determination of the number of axles for each car and length between axles

      (2) Car speed

   c. Processing: On a priority interrupt basis, wheel detector data (axle passage and passage time), photo cell data (beginning and end of a cut, coupled cars), and radar data (cut length) are checked and correlated to determine the number of axles for each car. Assumption is made as to the standard distances between axles, distance from coupling point to the first set of axles, and the maximum number of axles on a car, etc.

6. Post-hump Car Identification and Verification

   a. Input: (1) Output from the determination of car axle count routine

      (2) Hump list

      (3) Pin-puller list

b. Output: Updated car and cut identification in crest-to-master retarder inventory file.

c. Processing: This routine reconciles car and cut information in the hump list and pin-puller's list with the sensor-obtained information by confirming the number of cars in each cut, car lengths, cut lengths, and so forth. In the event of a discrepancy (may be caused by sensor inaccuracy or mistakes in pin-pulling, etc.), corrective entries will be made to reflect the true tag number of cars. A crest-to-master retarder car inventory file ("as humped list") is maintained in order of car position and cut configurations. Each car record also contains data related to speed control and rollability functions.

7. <u>Weight Scale Routine</u>

a. Input: (1) Car axle count and identification information

(2) Weight of car

(3) Car record

b. Output: (1) Enter scale weight to car record in the "as humped" list for revenue and speed control purposes.

(2) Initiate re-routing in the event the car is overweight.

c. Processing: The scale (placed after the car identification and speed sensors) obtains gross weight of each car, and based on other attributes from the car record (car type, capacity, tare weight, length, height, etc.), the routine will determine whether the car is overweight. If so, the car will be re-routed.

The gross weight of the car will be recorded in the car record for two purposes:

(a) For waybill information under the MIS function

(b) For speed control.

8. Weight Classification

a. Input: Weigh rail reading

b. Output: Weight category classification to master retarder control

c. Processing: The weigh rail's function is to classify each car into a weight class (e.g., light, medium, heavy) in order to activate master retarder control. This function is a locally distributed PC function which may be handled by either an analog device or a microprocessor. Its output will go directly to master retarder control. It can be viewed as an inner loop of a speed control function (the outer loop being the scale weight routine processed by the PCC for a more global application).