RUN TICKET OIL SALES ALLOCATION SYSTEM

ABSTRACT

This project delivers a scaled down, International Business Machines Personal Computer (IBM-PC) based, interactive prototype of a proposed system to process run ticket information. The project achieved 3 main goals:

1) to develop algorithms to correct field measurements of both hydrocarbon fluid rates and volumes to rates and volumes at standard conditions (14.7 pounds per square inch absolute or psia, and 60 degrees Farenheit).
2) to code algorithms to allocate fluid volumes sold from a tank facility back to the individual producing wells and formations.
3) to provide a PC based prototype of custom software for a mainframe computer which would be suitable for demonstrations to potential clients.

Secondary goals involved:

1) developing a file design in third normal form (minimizes potential update anomalies).
2) maintaining maximum flexibility for the addition of modules to enhance capabilities at a later date.
3) providing recommendations for further development work.

All programs run interactively and are coded using Microsoft COBOL compiled under MS-DOS 2.0.
# Table of Contents

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abstract</td>
<td>1</td>
</tr>
<tr>
<td>1) V10C</td>
<td>2</td>
</tr>
<tr>
<td>2. Table of Contents</td>
<td>3</td>
</tr>
<tr>
<td>3. Introduction</td>
<td>4</td>
</tr>
<tr>
<td>1) Procedure for the Project</td>
<td>4</td>
</tr>
<tr>
<td>4. Environment</td>
<td>5</td>
</tr>
<tr>
<td>5. File Descriptions</td>
<td>6</td>
</tr>
<tr>
<td>6. Module Descriptions</td>
<td>9</td>
</tr>
<tr>
<td>7. Fluids Properties Algorithms</td>
<td>12</td>
</tr>
<tr>
<td>1) Corrections to Standard Conditions</td>
<td>12</td>
</tr>
<tr>
<td>2) Corrections to a 24 Hour Basis</td>
<td>14</td>
</tr>
<tr>
<td>3) Algorithm Implementation</td>
<td>14</td>
</tr>
<tr>
<td>4) Algorithm Testing</td>
<td>16</td>
</tr>
<tr>
<td>8. Sales Allocations Algorithm</td>
<td>17</td>
</tr>
<tr>
<td>9. Summary, Conclusions, and Recommendations</td>
<td>18</td>
</tr>
<tr>
<td>10. Bibliography</td>
<td>22</td>
</tr>
<tr>
<td>11. Appendix</td>
<td>23</td>
</tr>
<tr>
<td>1) File Designs</td>
<td>24</td>
</tr>
<tr>
<td>2) IPO Charts</td>
<td>25</td>
</tr>
<tr>
<td>3) Test Data and Results</td>
<td>26</td>
</tr>
<tr>
<td>4) Program Listings</td>
<td>27</td>
</tr>
</tbody>
</table>
INTRODUCTION

Oil producing companies currently keep records that are used to manually allocate oil sales volumes from tank batteries and miscellaneous fluids collection facilities back to the producing wells or leases, as the case may be. They are generally required to do this by various regulatory authorities, or by the various partners which share production originating from individual properties. A general description of the manual allocation process follows:

1. Run tickets are used to record miscellaneous information about fluid volumes purchased each time a purchaser drains fluids from a production company tank to purchaser facilities (i.e., either a tank truck or a purchaser pipeline).

2. Individual well tests are periodically conducted for each active well. These tests gather data about produced volumes of oil, water, gas, and SS&W (trash produced along with the fluids), as well as information about the testing environment (oil gravity, wellhead temperature, etc.). The tests are usually for only a short duration, and therefore the test results are used to extrapolate to the theoretical sustained producing rates for a 24 hour time period.

3. The well test rates are corrected (References 1 & 2) to yield rates at standard conditions (14.7 psia, 60 degrees farenheit). The sum of the rates for all wells feeding a specific fluid collection facility is calculated, and then used to arrive at a theoretical fluid contribution from each well to the total gathering facility sales volume. Thus the percentage of sales contributed by each well is calculated, multiplied by the gross total sales volume, and the result is then allocated to the proper well or lease and used to calculate other required parameters such as royalties to land owners, state and local taxes, and payments due to participating partners.

PROCEDURE FOR THE PROJECT

The automated system allocates sales volumes of liquid hydrocarbons from gathering facilities back to individual producing wells. In a general concept, the processing requires first collecting various run ticket tank volume measurements and then converting these tank measurements to barrel volumes, gathering periodic well test data and converting to theoretical sustained production rates, and then allocating from the total sales volume to obtain the individual property sales volume. All of this data is gathered using menus and screens for input from the user.
ENVIRONMENT

1. Implementation is interactive on an IBM compatible microcomputer (no 8087 co-processor or hard disk required).

2. All data is collected, validated, and accepted via interactive screens using Microsoft COBOL. It is then written to floppy disk files.

3. Microsoft COBOL modules access the disk files to perform allocations based on only the most recent well test and print reports. All well test information is kept for use in future extensions to this project (such as generating production rate decline curves).
FILE DESCRIPTIONS

A total of 8 files is required to implement the prototype project, and have the file design in third normal form (to protect against update anomalies). All files have an extra field equivalent to at least 20% of the field length to be used for future expansion. As this space is allocated anyway, I have elected to use the expansion space as a remarks field for each record. The fields in the files are shown on the accompanying file layout sheet, and a general description of each file follows:

1. TANK FILE - Used to relate a gathering tank system to a lease and a productive horizon (formation). This file is indexed using tank code as a unique key value, and both lease code and formation code as alternate keys with duplicates allowed. The alternate keys will potentially be used in a later extension of the prototype project to list parameters for all tanks feeding from a specific lease or formation. Each record in this file has a single field used to contain the conversion factor from inches of fluid in the tank to an equivalent volume measured in barrels.

Some clients may be using tanks with varying diameters, so that a range of conversion factors might be required for a single tank. In this case the appropriate conversion factor would be determined based on the height of fluid measured. For this reason, consideration should be given to having a conversion factor file for each potential tank type. Records in this file would contain height ranges and conversion factors for the respective ranges. The tank file as currently used would need modification to use a code to access the proper tank table, rather than using a constant conversion factor.

2. LEASE FILE - Used to relate a lease code from any other file to a lease name. This file is indexed based on lease code as a unique key. It also contains a field for lease name, and consideration should be given to including other data unique to each lease, such as royalty owners, producing partners, working and revenue interests, etc.

3. FORMATION FILE - This file is used to relate a formation code used in any other file to information to identify a producing formation. The file is indexed using the unique formation code assigned to each productive horizon. Fields in it include the formation name (both an intra-company name and a name specified by a regulatory agency) as well as
the formation depth, and the formation dissolved gas-oil ratio (GOR) at 14.7 psia and reservoir temperature. The GOR is used in the add well test module to correct measured producing oil rates to rates at standard conditions. Other fields which might be added include fluids properties data such as the initial GOR at discovery, initial reservoir pressure and temperature, gas gravity, etc.

4. **WELL TEST FILE** - Used to record a variety of information obtained from periodic well tests. The file is indexed using the unique key created from the concatenation of lease code, well number, formation code, and test date. This is based upon the reasonable assumption that no well will be tested more frequently than once per day. The formation code is included to enable entries for wells producing as dual completions. Included are fields to contain the number of hours the well is actually tested; oil gravity; separator pressure; stock tank temperature; separator temperature; volumes of oil, water, and gas produced; gas gravity; and calculated oil, water, and gas theoretical sustained producing rates.

Consideration should be given to including data items such as casing wellhead pressure, tubing wellhead pressure, production method (flowing or on pump—sucker rod, gas lift, submersible, etc.), pumping unit size, pump bore, rod string size, compressor system it feeds, choke size, tubing and casing size, and presence of a tubing anchor. All of this miscellaneous data could be of great value when the test information is used for other applications, such as decline curve analysis.

5. **RUN TICKET FILE** - Used to contain data from the purchasers' run tickets, along with a field to identify the tank battery drained, and the purchaser. The file is indexed using the unique key value generated from the concatenation of the sales date, tank number, and initial fluid height. The initial fluid height must be added to the key since although a purchaser might make several sales runs from a tank in 1 day before finally draining it, the initial fluid height in the tank should be different than on the previous run. Additional alternate key fields with duplicates allowed will be tank number, so that all run tickets for a given tank facility can be accessed (i.e., browsed), and purchaser code so that the volumes sold to each purchaser can be totaled periodically.

I strongly recommend that client companies use a
unique run ticket number for each oil run, and that the file use this as a unique key instead. This would alleviate some of the potential problems associated with updating the key fields currently used. Additionally, a LACT unit is an automated tank facility capable of measuring sales directly in barrels, so no fluid heights would be measured. As the current concatenated primary key of the file uses initial fluid height as a parameter, this software would not be applicable to LACT units.

Other fields are used to contain the final fluid height remaining in the tank after the run is made, the tank temperature, the tank oil gravity, the BS&W content, and the calculated oil volume (in barrels) collected from the facility.

6. **PURCHASER FILE** - Used to contain the information unique to each purchaser. This file is indexed using the unique code assigned to that purchaser. The other field is the purchaser's name, but consideration should be given to including the purchaser's address, phone number, posted product prices, payment terms, and other relevant data.

7. **TEMPORARY FILE** - Used as a scratch file to aid in the allocation processing. It is a sequential file containing, for a specific tank battery with allocations required, the most recent well test for each well feeding the tank battery. Fields in it contain the date a well was tested, the lease code, well code, and theoretical producing rate based on the most recent well test.

8. **AUDIT FILE** - A text file used to record transaction activity for all processing against the data files.
MODULE DESCRIPTIONS

The greeting is accomplished via the DOS autexec.bat file. Upon entering the program the menus are function oriented, rather than file oriented, and they allow the user to select to enter the following modules:

1. **MAIN MENU** - Allows the user to select a function: Add to files, Update files, or Print a report. It also creates the audit file if needed, and the user approves.

2. **ADD MENU** - Allows the user to select addition to: Purchaser file, Lease file, Formation file, Tank file, Well Test file, or Run Ticket file.

3. **UPDATE MENU** - Allows the user to modify the Run Ticket file only. No update of the Well Test file is allowed since calculated theoretical production rates used in the allocations are based on Well Test contents. Consideration should be given to allowing this capability, and correcting all affected oil allocations, in the next version of this program. The remaining files have only "stubs" available for update modules, as they will vary considerably from client to client, depending on the final design that is selected.

4. **PRINT MENU** - Allows the user to print a selected report. The only reports implemented in this prototype version are to print out the contents of the lease file, the purchaser file, or to print and perform sales allocations. The selection to print sales allocations also allows the user to browse the run ticket file, and consideration should be given to including the allocation choice as a function of the update module.

**Note: CREATE THE FILES IN THE FOLLOWING ORDER!!**

5. **ADD/CREATE PURCHASER** - Allows addition of a purchaser and creates the purchaser file and audit file if required, and the user approves.

6. **ADD/CREATE LEASE** - Allows addition of a lease and creates the lease file and audit file if required, and the user approves.

**Note: EACH OF THE FOLLOWING ADD AND UPDATE MODULES ACCEPT AND VALIDATE VARIOUS DATA ITEMS. IN MOST CASES THE VALIDATED DATA IS RESTRICTED TO A RANGE OF VALUES SO THAT THE FLUIDS PROPERTIES CORRELATIONS USED WILL BE VALID. SEE THE MODULE CODE FOR DOCUMENTATION.**

PAGE 9
7. **ADD/CREATe FORMATIONS** - Allows addition of a formation and creates the formation file and audit file if required, and the user approves.

8. **ADD/CREATe TANKS** - Allows addition of a tank and creates the tank file and audit file if required, and the user approves. Both the lease and formation files must have been previously created and contain the lease and formation codes which feed the tank.

9. **ADD/CREATe WELL TEST** - Allows addition of a well test and creates the test file and audit file if required, and the user approves. This module processes the well test data to determine the flow rates corrected to standard pressure and temperature. Essentially it calculates an oil formation volume factor (based on API gravity and surface temperatures and pressures) to convert from reservoir barrels to standard barrels. Both the lease and formation files must have been previously created and contain the lease and formation codes for the well completion.

10. **ADD/CREATe RUN TICKETS** - Allows addition of a run ticket and creates the ticket file and audit file if required, and the user approves. This module processes the run ticket data to determine the total liquid volume sold. Essentially it calculates the total fluid transferred off lease based on the conversion factor for the tank and the change in fluid height in the tank, and then obtains the oil sold by correcting the total volume for BS & W content.

11. **UPDATE RUN TICKETS** - Allows modification of many of the data fields of a run ticket and creates the audit file if required, and the user approves. It allows the user to select a starting point to sequentially browse the run ticket file backwards or forwards based on values of the primary key, or the tank code, or the purchaser code. This module processes any updated run ticket data to determine the total liquid volume sold. Essentially it calculates the total fluid transferred off lease based on the conversion factor for the tank and the change in fluid height in the tank, and then obtains the oil sold by correcting the total volume for BS & W content.

As currently written, the module allows for simple deletion and modification of run ticket records.
Consideration should be given to modifications to compensate for the effects of having allocated sales based on a run ticket, and then wanting to delete or modify the run ticket at a later date.

12. PRINT ALLOCATIONS MODULE – Used to access the files and, for a specified run ticket selected via browsing, calculate sales allocations for each well and print a listing of the allocations.

13. PRINT LEASES – This module allows the user to print the contents of the lease file.

14. PRINT PURCHASERS – This module allows the user to print the contents of the purchaser file.