Flow Diagrams for Grain Handling Functions

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Goals for This Lecture

• Introduce flow diagrams for whole-grain handling, storing, drying, and cleaning

• Follow a flow diagram to see processes, functions and steps with their corresponding relationships

• Identify how process changes affect the flow of the grain

• Identify potential compromises in safety

• Identify how flow diagram ties directly to physical layout.
Facility Background

• Inland grain terminal

• Increase the receiving and load out rates

• Ability to handle corn, soybeans, wheat and milo

• Able to segregate grains

• Capacity
  • Storage capacity 564,000 bushels
  • Complex storage capacity 4.2 million bushels
Facility Background (cont.)

- Truck receiving to rail loading facility

- Unit train loading facility
  - Union Pacific Railroad
  - 110 cars to a unit train
  - 4000 bushels per train car (440,000 bushels total for the unit train)
  - Track layout at load point allows 25 cars to a string of cars
Typical Line Flow
Physical Layout at Grade

Pit #1

Pit #2
Typical Receiving Season

• Wheat
  • June: south and west
  • August (late) and September: northern states

• Corn and Beans
  • Beans come out first, then corn but these often come out at the same time
  • Start about September 1 and will go into November
Overlap Between Crops

• Harvest vs. Facility

• Examples
  • Southern Illinois – wheat, corn and soybeans
  • Eastern Kansas – late wheat, milo, soybeans and corn
Typical Line Flow
Legend and Grain Handling Terms

**Legend**

- **Motion Sensor**
- **Diverter Valve**
- **Level Indicator**
- **Fan**
- **Scale**
- **Gate (C/%)**
- **Gate (Manual)**
- **Enclosed Belt**
- **Plug Switch**
- **Temp. Cable**

**EQUIPMENT ITEM NUMBER**
- **Equipment Number**
- **Equipment Area Classification**
  - 1XX = Receiving System
  - 2XX = Storage System
  - 3XX = Reclaim System
  - 4XX = Drying System
  - 5XX = Loadout System
  - 6XX = Filter System
  - 7XX = Miscellaneous System
- **Equipment Letter Abbreviation**
  - AD = Arm Drive
  - AF = Aeration Fan
  - AR = Airlock
  - BF = Bin Filter
  - BL = Blower
  - BS = Bin Sweeper
  - BW = Bulk Weigher
  - CB = Conveyor Belt
  - CD = Conveyor Driv
  - CE = Conveyor Elevator
  - CS = Conveyor Screw
  - CT = Controls
  - DB = Dust Suppression Hopper
  - DI = Divider
  - DR = Dryer
  - DS = Distributor
  - DV = Diverter Valve
  - FF = Filter Fan
  - FP = Fall Protection
  - GE = Gate Electric
  - GH = Gate Hydraulic
  - GM = Gate Manual
  - GO = Grain Sampler
  - HL = High Level
  - LG = Lower Gatherer
  - LL = Low Level
  - LT = Level Transmitter
  - MG = Magnet
  - ML = Manlift
  - MS = Moisture Sensor
  - RF = Roof Fan
  - RS = Retractable Spout
  - SB = Surge Bin
  - SC = Screener
  - SP = Sampler
  - TC = Temp Cable
  - TP = Truck Probe
  - TS = Telescoping Spout
  - UG = Upper Gatherer
  - WF = Wall Fan
  - WS = Weigh Scale

**General Notes:**
1. Reference equipment list for motor HP & electrical.

**Commodity**

<table>
<thead>
<tr>
<th>Corn</th>
<th>Soybeans</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>45-48</td>
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**Angle of Repose**
- Corn: 21 degrees
- Soybeans: 21-28 degrees

**Spouting Specifications**

- Receiving System = 40 degree min. w/ urethane
- Reclaim / Loadout System = 40 degree min. w/ urethane
- Screenings Spout = 50 degree min. x 10 ga., unlined

- Spout Size from Bin = 65 bu./sq. in. per hour.
- Spout Size from Drag Conveyor = 70 bu./sq. in. per hour.
- Spout Size from Belt Conveyor or Leg = 70 bu./sq. in. per hour.
Receiving - Two Gravity Pits
Vehicles Received
Receiving - Conveyed Pits

- Alternative to gravity pits
- Allows hopper bottom truck to open either hopper without moving
- Conveyor required to reclaim and transfer to second conveyor going to legs
- Dust control system required
- Often utilized by processing facilities or port terminals
Receiving - Dust Control
Receiving - Cleaners and Top Distribution
Receiving - Cleaning

- Cleaning requirements
- Grain type to be cleaned
- Cleaning frequency
- Cleaned for
  - shipping or
  - in-house use
Receiving - Clean Grain, Better Quality

- Clean grain
  - Remove foreign material
  - Remove dust
  - Remove small particulates

- Better quality
  - Internationally: fines maximum percentage of 4%
  - Food processes: fines closer to 0%
Receiving - Bin Reclaim
Aeration of Bins

- Often used for longer term storage
- Rarely used in process bins or where bins are cycled often
- Aeration amount varies to the product being stored.
Receiving - Rail
Conveyed Receiving Rail Cars
Rail Load Out Bulk Weigh Scale
Sample and Quality Requirements
Scaling for Inventory
Material Handling Rates and How They Are Established

• How will we be receiving?

• How often do we receive?

• How many commodities will we be receiving?

• Are other functions happening at the same time as receiving?
Transfer Rate

- Determined by need
- Can transfer be done in off hours?
- Is transfer needed to support loading rate?
- Where is the transfer going to and coming from?
- Ability to transfer while receiving and/or loading are occurring
Temperature Detection

- Bin height
- Bin diameter
- Fill and empty frequency
- Flat floored or hopper bottom
Safety Devices and Function

- Slack chain
- Plug switch
- Bearing detection
- Alignment sensors
- High level
- Low level
Facility Limitations (cont.)

• Why duplication?
• Can equipment be substituted?
• Can equipment serve multiple uses?
Facility Limitations

• What can be taken out of service and not impact operations

• Can equipment be substituted?

• Alternatives if out of service for extended period

• How to get back in service
Service Needs

• If it is mechanical, electrical or built by humans it will break.

• **SAFE** access to all components, even sensors and small motors

• Access needs to be safe, allowing for tie-off if required

• Maintain company safety standards
Example of Service Requirement: Receiving Leg Motor

- Where is this located?
- Can I service this safely?
- What do I do if this needs replacement?
- What else is in this area that needs service?
When To Modify the Flow

- Grain flow is modified
- Equipment change
- Equipment modification (sped up or slowed down)
- A process is added to facility
- Regulatory change (i.e. dust standard is changed)
- New ownership
Complex Facility Mandates a Complex Flow
Complex Facility Layout
Relating Flow to Physical Structure
Summary

• The flow diagram is our road map to the facility. It coordinates how the grain should flow and dictates the design of the facility and sizing of the equipment.

• Understanding how grain flows through a facility helps employees in their understanding of when things are working properly.

• The flow can and should be used for new employee training as to how things should work and if not why they are not.
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