# Basic Gas Flow Dynamics and Related Scheduling Factors

## Pipeline Segment

**Wholesale Gas Quadrant**
**North American Energy Standards Board**

**Gas Electric Coordination Task Force**

**January 29, 2004**

# Overview

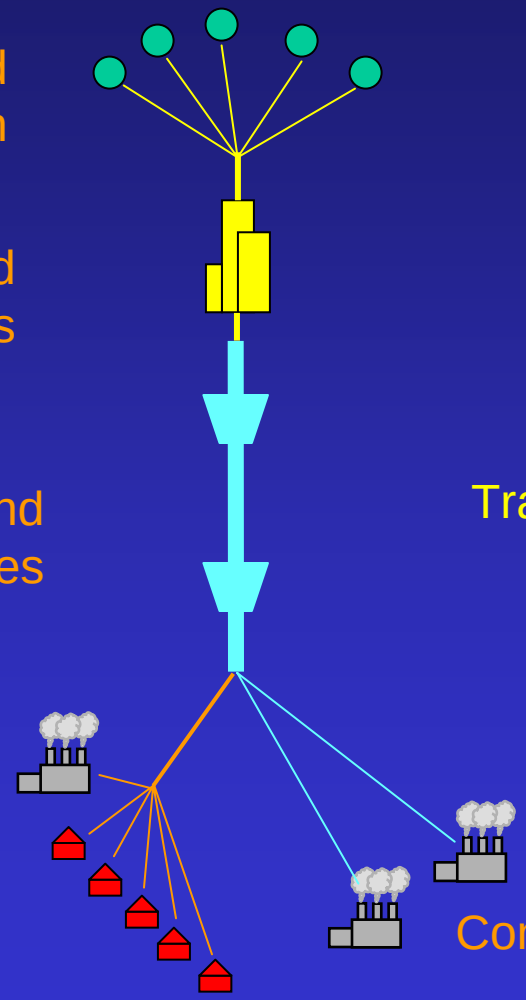
- Gas flow
- Gas day
- Gas scheduling basis
- Gas scheduling process

# Factors Involved in Delivering Gas to Market

- **Supply source**
  - Producer
  - Marketer
- **Contracts (types, credit)**
- **Transportation facilities**
  - Gathering
  - Transmission
  - Distribution
- **Timing (physical, administrative)**
- **Coordination**

# The Industry Today

| *Corporate Entities* | *Function* |
| --- | --- |
| Exploration and Production | Find, drill and complete wells |
| Field Services | Gather and process |
| Interstate and Intrastate Pipelines | Transport |
| Distribution (LDC)<br>Commercial Consumers<br>Other End Users | Distribute / End Use |
| | Commercial Consumers |



# Transportation Infrastructure

- **Pipeline facilities**
  - Supported by firm contracts
    - New pipelines are usually fully subscribed
    - Terms are generally for 10 to 20 years
  - One to four years for in-service
    - Regulatory/environmental
    - Material/construction
- **Operating rules**
  - DOT (safety)
  - FERC (tariffs)
    - Firm contracts
    - IT contracts

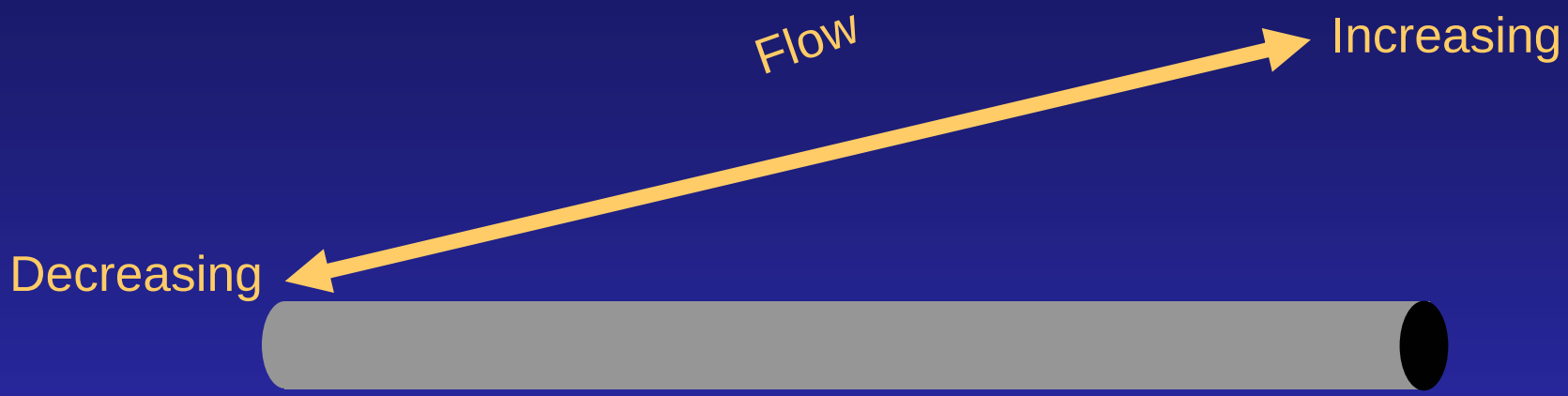
# Physical Gas Movement

- **Physical commodity**
- **Flow speed ~ 25 mph**
  - 1500 mi Gulf to NYC
  - 2+ days for transportation
- **Pressure**
  - High to low
  - Interconnect coordination

# Gas Flow Dynamics
# Determinants Affecting Flow

- **Pipeline properties**
  - Diameter (20” to 42”)
  - Length
  - Strength (800# to 1400#)
  - Efficiency/roughness
- **Delivery and facility pressures**
- **Gas temperature and specific gravity**
- **Elevation change**

# Gas Flow Dynamics
## Flow Variation




| | |
|---|---|
| Smaller diameter | Larger diameter |
| Longer length | Shorter length |
| Lower Upstream Pressure | Higher Upstream Pressure |
| Higher Downstream Pressure | Lower Downstream Pressure |
| Higher roughness | Lower roughness |
| Higher gas temperature | Lower gas temperature |

# Gas Flow Dynamics
## Flow Rates

- **Manage flows to**
  - Deliver target quantity in specified period (day)
  - Meet pressure obligations
  - Meet gas quality requirements
- **Manage modifications to flow rates**
  - Notification
  - Capacity
  - Coordination

# Gas Flow Dynamics
## Transportation Operating Terminology

- ***Receipts*** – Gas entering pipeline
  - also Supply
- ***Deliveries*** – Gas exiting pipeline
  - also demand
  - also load
  - also market
- ***Throughput*** – Flow rate of gas through pipeline
- ***Linepack*** – Amount of gas in the pipeline
- ***Packing*** – Increasing linepack
- ***Drafting*** – Decreasing linepack

# Gas Charaacteristics Related To Flow Flexibility

- **Natural gas is compressible**
- **Pipes and compression can provide**
  - Variability in delivery rates
  - While receipts are constant

# Operating Flexibility from Linepack

## Linepack

- **Definition:  Amount of gas in pipe**
- **Function of:**
  - Pipe size - length, diameter
  - Pressure
    - Higher pressure - more linepack
    - Lower pressure - less linepack
- **Usage Limits**
  - Delivery pressure obligations
  - Maximum Allowable Operating Pressure (MAOP)
  - Available compression

## Usable Linepack

- **Maximum variation in linepack while...**
  - Moving scheduled *daily* quantities
  - Meeting all pressure requirements

# Operating Flexibility from Linepack

## Linepack and Intra-day Flexibility


*Daily* Supply equals *Daily* Delivery

# Operating Flexibility from Linepack

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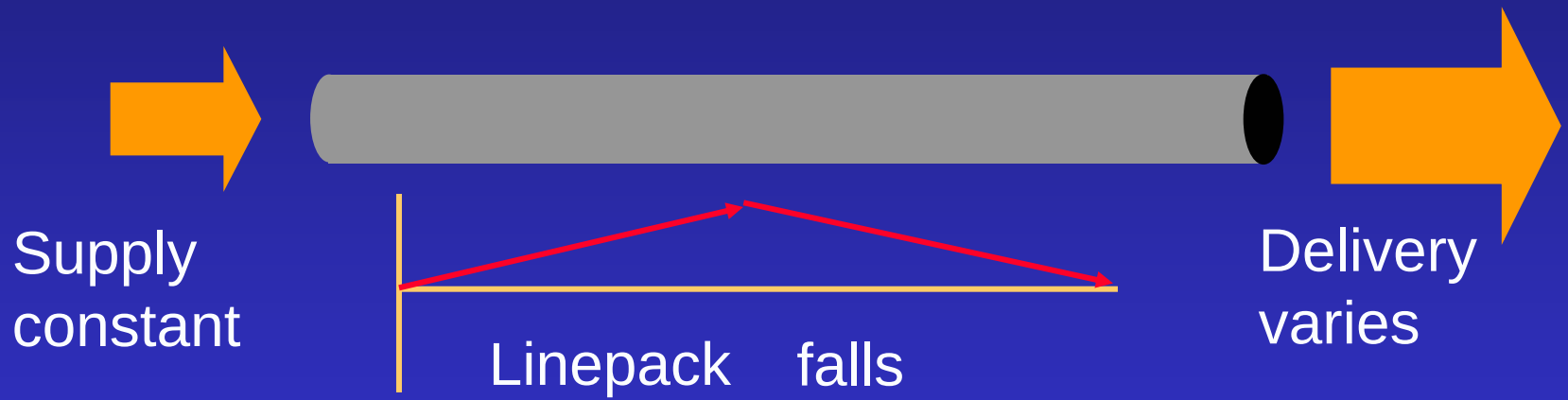
# Operating Flexibility from Linepack

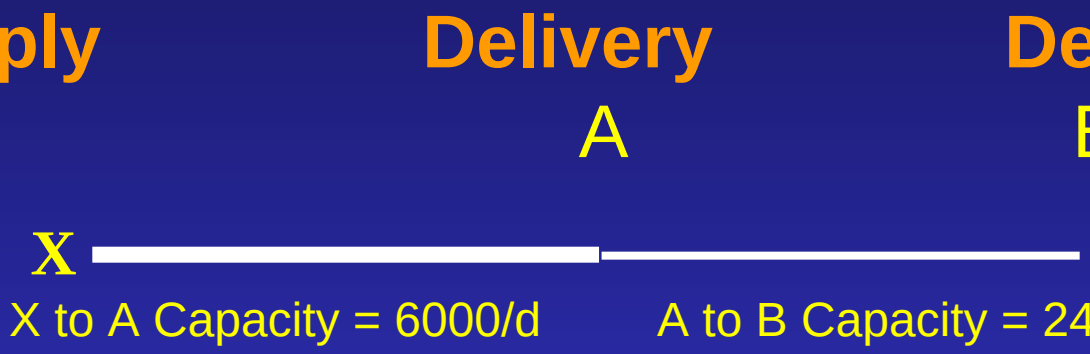
## Linepack and Intra-day Flexibility




*Daily* Supply equals *Daily* Delivery

# Operating Flexibility from Linepack

## Variable Flow Example




**Point capacities:**

**A = 3600/d or 150/hr**

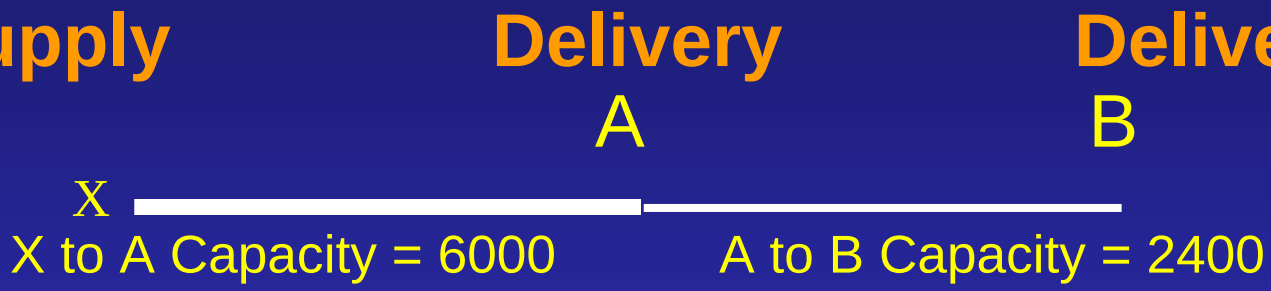
**B = 2400/d or 100/hr**

**Shippers A and B each nominate for daily deliveries of 2400 (X to A and X to B)**

Scheduled Flow = 4800/d = 200/hr

# Operating Flexibility from Linepack

**EXAMPLE**




**Nominations: Shipper A = 2400/d Shipper B = 2400/d**

**Gas supply: 4800/d = 200/hr**

| Hours | Flow Rate | | Total Flow | |
|---|---|---|---|---|
| | **A** | **B** | **A** | **B** |
| 1 – 6 | 50 | 100 | 300 | 600 |
| 7 – 18 | 150 | 50 | 1800 | 600 |
| 19 – 24 | 50 | 100 | 300 | 600 |
| **Totals** | | | **2400** | **1800** |

# Scheduling Terminology

- **Operator – pipeline, producer, LDC, Plant**
- **Shipper (Contract Holder)**
- **Receipt and delivery points (contractual/secondary)**
- **Capacity**
  - Mainline (flowing)
  - Point (specific location)
- **Capacity allocation (match of nominations to physical)**
- **Pools (supply aggregation)**
- **Nomination (request for space to transport gas)**
- **Confirmation (verification of space downstream and gas supply upstream)**
- **Scheduled quantity (commitment of volume to transport)**
- **Imbalance**

# Origin of Existing Standards

- **Gas Day – March 1996**
- **Scheduling Timeline – December 1997 (Intra-day)**
- **Standards were based on**
  - Compromise (the “Greater Good”)
  - Safety
  - Impact to operators
  - Impact to shippers
  - Impact to markets

# NAESB's National Gas Day

- **Standard 1.3.1 – Standard time for the gas day should be 9:00 a.m. to 9:00 a.m. (central clock time)**

  Resulted in coordinated and consistent transactions (nominations), measurement and gas flows across the grid

# Gas Day Criteria

- **National Standard**
  - Single times/periods for all parties
  - Consistent measurement at interconnects
  - Minimize timing-related imbalances
  - Promote operational safety
  - Availability of marketers and financial markets
  - Minimized maintenance impact
- **Operational Basis**
  - Time when flow changes will occur
  - Time convenient to all time zones
  - Compromise to achieve “best fit.”

# Scheduling Timeline Origins
## (Daily / Intra-Day)

- **1995 – Original single nomination for the gas day (adopted in March 1996)**
  - One intra-day with no specific timeline
- **FERC Order 587C directed intra-day nominations (March 1997)**
  - GISB Task Force
    - More than 20 meetings in 1997
    - Many compromises
    - Final proposal in December 1997

# Scheduling Timeline Criteria

- Conform to Gas Day
- Permit changes when operationally supportable
- Provide for grid-wide coordination
- Prior cycle information known before next cycle
- Minimize imbalances
- Staffing considerations

# Scheduling Timeline

| Nomination Deadline for Shippers / Poolers | Point Operator Confirmation Deadline | Receipt of Final Scheduled Quantities by Shippers & Point Operators | Effective Start Time for Gas Flow |
|---|---|---|---|
| 11:30 a.m. CCT* Timely | 3:30 p.m. CCT | 4:30 p.m. CCT | 9:00 a.m. CCT on the next gas day |
| 6:00 p.m. CCT Evening | 9:00 p.m. CCT | 10:00 p.m. CCT | 9:00 a.m. CCT on the next gas day |
| 10:00 a.m. CCT Intraday 1 | 1:00 p.m. CCT | 2:00 p.m. CCT | 5:00 p.m. CCT on the same gas day |
| 5:00 p.m. CCT * Intraday 2 | 8:00 p.m. CCT | 9:00 p.m. CCT | 9:00 p.m. CCT on the same gas day |

*** IT Bumping not allowed during these nomination cycles**

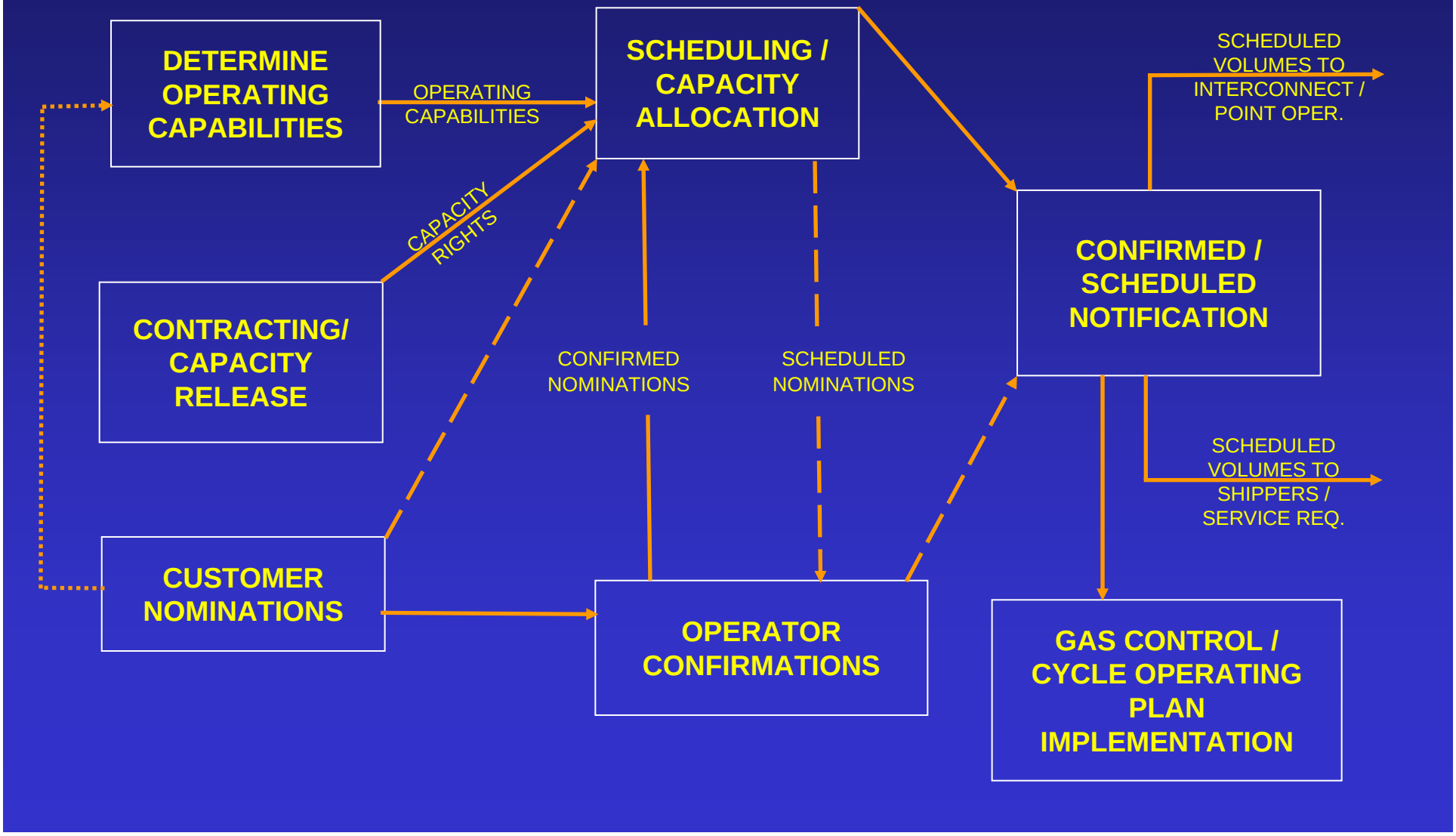
# Scheduling Timeline
## Other Issues

- **Daily nominations / flow rate responsibility**
  - Standard 1.3.9 –
    - Nominations in daily quantities
    - Interconnected parties agree on flow rates
- **Firm vs IT (Tariff rules)**
- **Capacity Release/Recalls**
- **Intra-Day modifications**
  - Bumping
  - EPSQ

# Gas Flow / Scheduling Summary

- **Natural Gas is a physical resource**
  - Gas flow must be planned
  - Physical factors impact delivery rates
- **Pipelines operate under specific rules**
  - Scheduling timeline
  - Firm vs IT
  - Capacity release and recalls
  - Allocation/balancing
- **Reliability is a key issue**
  - Communication
  - Repetitive process

# Scheduling Process Overview
## (Four Times Daily)



# Determine Operating Capabilities

- Design capabilities
- Availability of facilities
- Temperature / specific gravity changes
- Location / level of inputs/outputs (nominations) for the cycle
- Required system operating adjustments

# Scheduling / Capacity Allocation

- **Nominations compared to operating capabilities to identify points of constraint**
- **Capacity allocated to contracts nominated at or through the point of constraint on the basis of tariff rules. Typical rules are:**
  - Firm within the path (primary)
  - Firm out of path (secondary)
  - IT / Overrun
- **Nominations are allocated capacity at points based on tariff rules. Typical rules are:**
  - Primary contract point within the path
  - Secondary contract point within the path
  - Secondary contract point outside the path
  - IT / Overrun

# Operator Confirmations

- Confirm with operator using “lesser of rules”
- Confirm pooling transactions are complete and balanced
- Resolve mismatches if possible
- “Cut” volumes which cannot be confirmed indicating with a “reason code” why they could not be confirmed as nominated
- Consider Elapsed Prorata Scheduled Quantity (EPSQ) calculation before confirming nomination reductions during the intraday cycles

# Gas Control Cycle Operating Plan Implementation

- Make “set point” changes
- Communicate with field / measurement and interconnect operators
- Monitor operations and make changes to meet operating conditions and / or request nomination changes if flows do not match confirmed nominations

# Capacity Scheduling Considerations

- **Nomination Validations**
  - Contract rights
  - Impact of displacement transactions
- **Pooling and Title Transfer Tracking**
  - Additional requirement to match on – pipe transactions
  - Strictly an administrative function
- **Intra-day Complexities**
  - Elapsed Prorata Scheduled Quantity calculations
  - Adjustment of nominated flow rates for cycle
  - Intra-day releases / recalls
- **Confirmation Imbalances**
  - Mismatch between confirmed receipts and deliveries
  - Confirmation deadline issue

# Nomination Cycle Shippers / Service Requester Considerations

- **Nomination cycle considerations**
  - Capacity availability in cycles other than timely cycle
  - No bumping in Intraday two (2) cycle
  - Inability to nominate full contract MDQ
  - EPSQ limits on nomination reductions during the intraday cycles
- **Firmness of upstream supplies**
- **Coordination of transactions across transportation grid points**
- **Latency / Transportation Grid ripples**
- **Availability of key knowledgeable shipper/supplier business personnel. More problematic during “off” hours, evenings, weekends and holidays.**

# Capacity Scheduling Process Challenges

- **Maintain operational integrity of system**
  - Safety
  - Ability to meet contractual entitlements
- **Interdependence with suppliers, transporters and markets**
- **Balancing the pipeline (shippers and operators)**
- **Volume of transactions - timeline (meeting deadlines)**
- **Iterative nature of process (can result in imbalances being created)**
- **Forward look**
  - Customer behaviors
  - Weather
  - Pipeline & electric grid operating conditions (non-ratable flow issues)

# Summary

- Pipeline operating dynamics vary from pipeline to pipeline yielding different capabilities to deal with flow variations.
- Current WGQ standards are the result of careful / reasoned compromise among the five WGQ segments.
- Current WGQ standards are very interdependent so that one seemingly small change could have significant impact throughout their entirety.
- Scheduling processes are repetitive and highly interactive with all segments.
- Scheduling/flow reliability influenced by the cycle in which changes are initiated.
- Any change to processes/timelines must be weighed against reliability impacts and need to be cost effective.