Pipelines	• 49,000 miles of NG, Crude Oil and Refined Products
Storage (Salt Dome)	• 250 MMBbls of NGL, Refined products and Crude Oil • 14 Bcf of NG
Natural Gas Processing	• 25 NG processing plants
Fractionation	• 22 NGL and propylene fractonator
NGL Import/Export Terminals	• Houston Ship Channel Import offloading capacity – 14MBbls/hr • Export loading capacity – 27.5 MBbls/hr

Enterprise Products Partners L.P.

A LEADING NORTH AMERICAN PROVIDER OF MIDSTREAM ENERGY SERVICES

Cost Analysis of Pipeline Cathodic Protection Remote Monitoring Systems

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The Challenge

Develop a methodology to compare the cost of On-site Inspections vs Remote Monitor Inspections for Cathodic Protection current sources

NACE Houston Section
September Meeting

The purpose of this presentation is to offer examples of the methods used to determine the costs of remote monitoring and on-site inspections

What is Corrosion

A naturally occurring phenomenon commonly defined as the deterioration of a material (usually a metal) that results from a chemical or electrochemical reaction with its environment

What is Cathodic Protection

A technique to reduce the corrosion rate of a metal surface by making that surface the cathode of an electrochemical cell

Cathodic Protection Components

- <u>Rectifiers</u> are the power source for impressed Cathodic Protection systems (6x per calendar year not to exceed 2.5 months)

- <u>Bonds</u> are the safe path to transfer current back to a Foreign current source (6x per calendar year not to exceed 2.5 months)

- <u>Test Point</u> voltage readings measured during the Annual Survey verify the effectiveness of the Cathodic Protection System (1x per calendar year not to exceed 15 months)

Cathodic Protection Components
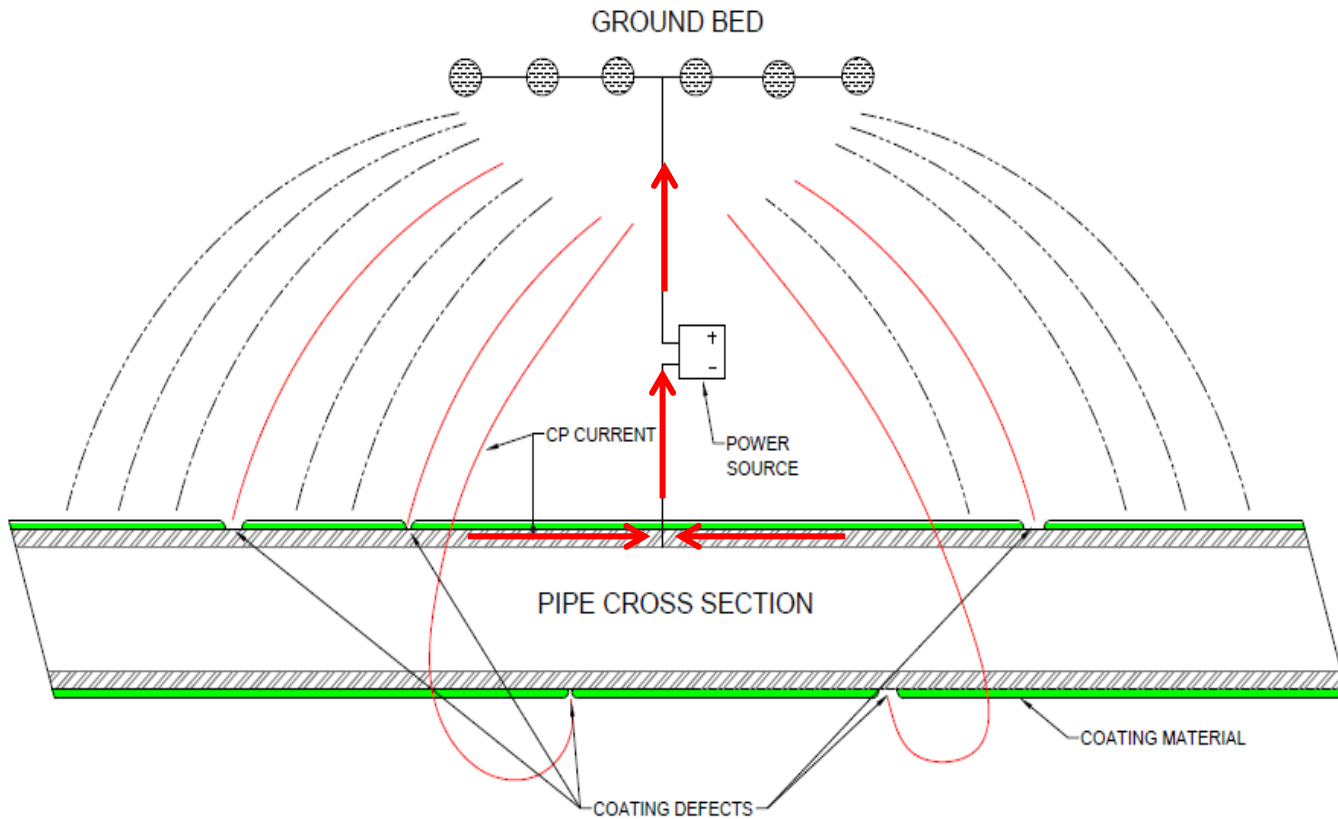
Options Considered for the Methodology

1) 100% on site Inspections
2) 100% remote monitor Inspections
3) Combination of 1 and 2:
    1) Option 3 requires considerations to prioritize locations for Options 1 or 2
        1) Geographic
        2) Critical Assets
        3) Available Qualified Personnel
        4) Cost of inspections
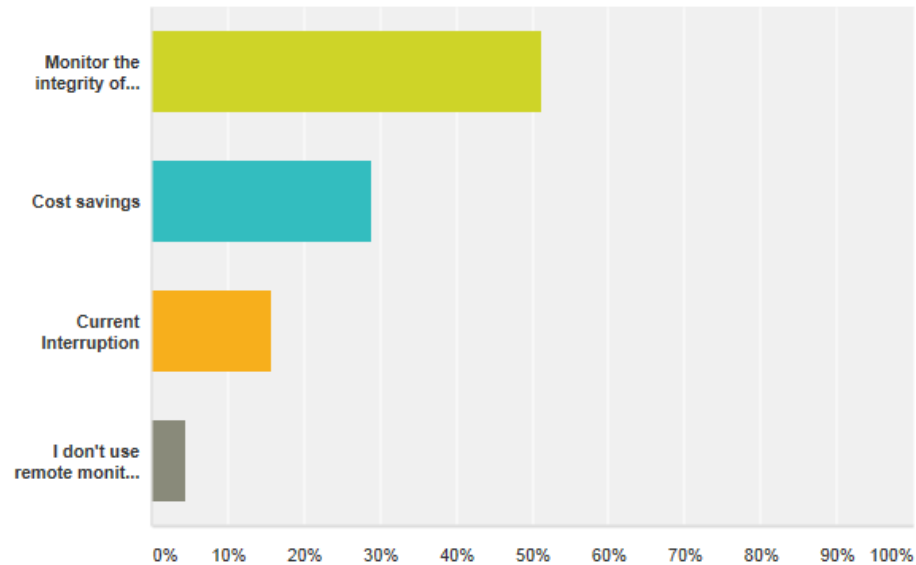
Methodology

- Determine the primary reason to use RM

- Interview the Suppliers and analyze responses

- Conduct a case study

  - Breakdown the costs

    - Annualize over 5 years

    - Cost Per Unit

- Cost Control Considerations

Q1

What is the primary reason you install remote monitors?

Answered: 45   Skipped: 0

Answer Choices	Responses	
Monitor the integrity of the CP system	51.11%	23
Cost savings	28.89%	13
Current Interruption	15.56%	7
I don't use remote monitors in my area	4.44%	2
Total		45

Remote Monitor Supplier Questionnaire

- Reliability Data for Remote Monitor Equipment

  o Predict the number of repairs

     - Uptime vs downtime

     - Meantime between failures

     - Reliability Factor

     - Cost of Repairs

- Product Reliability Test Results

  o Third Party Testing

Remote Monitor Supplier Questionnaire

- Existing policy to cover costs of units with high failure rates
    - o Warranty
    - o Replacement Costs
    - o Downtime Costs
    - o Time
    - o Material
    - o Travel

Remote Monitor Supplier Questionnaire

- Product Grades
  - Standard
  - Rugged
  - Price difference
    - Is the Reliability Factor affected

Remote Monitor Supplier Questionnaire

- Volume Discounts
  - Number of Units
  - Number of Transmissions

Remote Monitor Supplier Questionnaire

- Technical Support

  o Availability

  o Remote support

  o Site visit

  o Maintenance/Repair Service Plan

Remote Monitor Supplier Questionnaire

- Is it necessary to carry an inventory of Spare Units/Parts

  o Number of Units

  o Repair turnaround time

  o Delivery time if a new unit is needed

Remote Monitor Supplier Responses

Supplier #1

- Claim 96.2 % Reliability

- 1 year warranty

- Complicated Service Plans

- Data is readily available from the web site

- Limited number of channels

- Repairs – 2 weeks to 1 month turnaround

Supplier #2

- Claim 99% Reliability

- 18 month warranty

- Flat Fee Service Plan

- Data is readily available from the web site

- Multiple channels available

- Repairs – Turnaround of 1 week from receipt

Remote Monitor Supplier Responses

Supplier #3

- Claim 98% Reliability

- 5 year warranty

- Simple price structure

- 25% competitor product trade in

- Limited channels requiring multiple units

- Small Support Group

- Repairs - 6 days turnaround + shipping

The inspection cost analysis was completed in an area with 61 current sources and 66 remote monitors (5 spares)

The capital cost of the remote monitors (>$134K) annualized over 5 years.
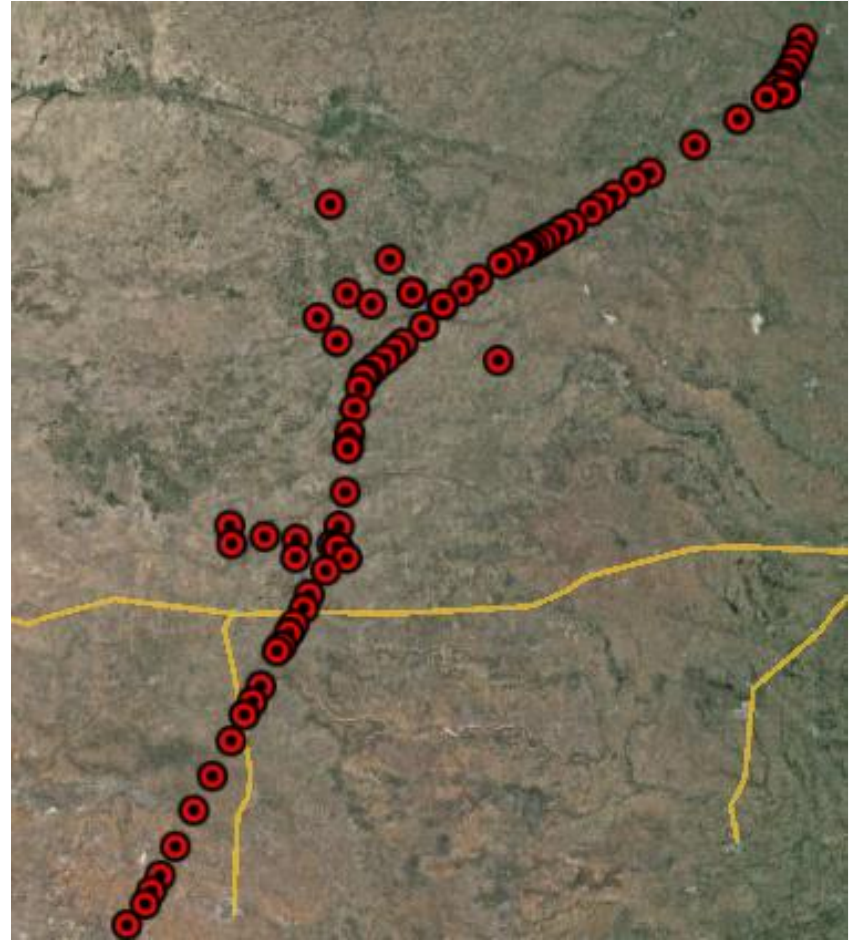
Case Study
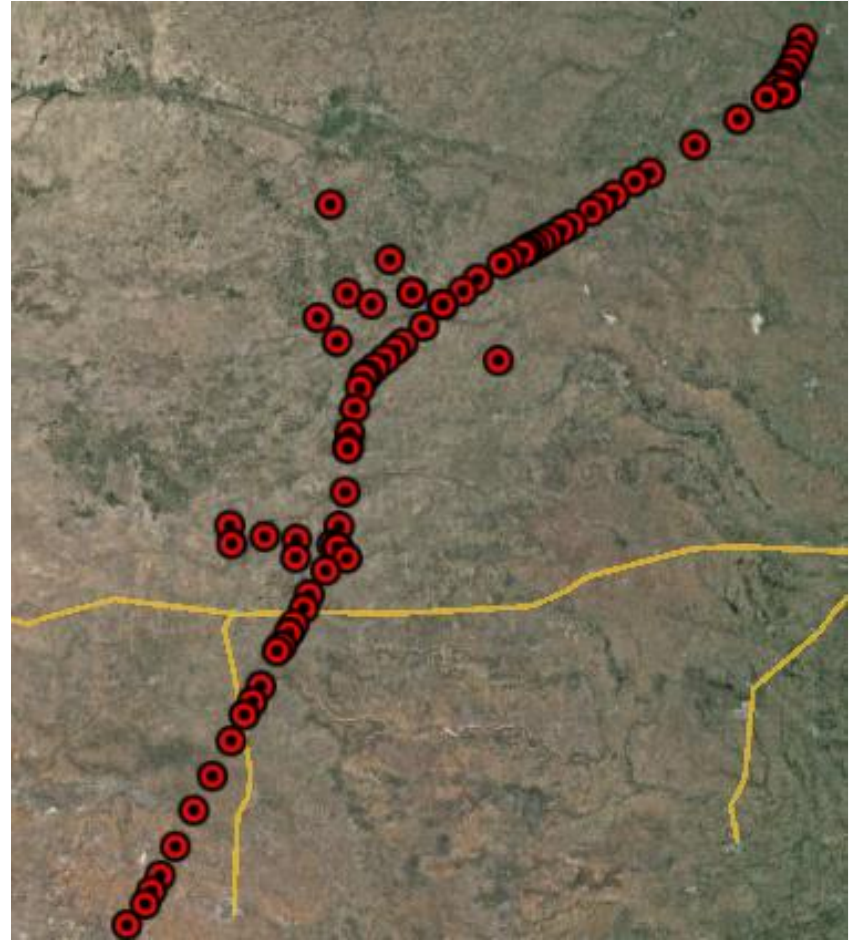## On Site vs Remote - **Periodic Inspection** Cost Analysis

On Site Inspection

- Total Cost per Cycle (61) - $5,134

  - x6   = $30,802

  - x12 = $61,603

    ### *Includes*

- Miles

- Vehicle Cost

- Labor Cost

- Lodging/Meals

Case Study
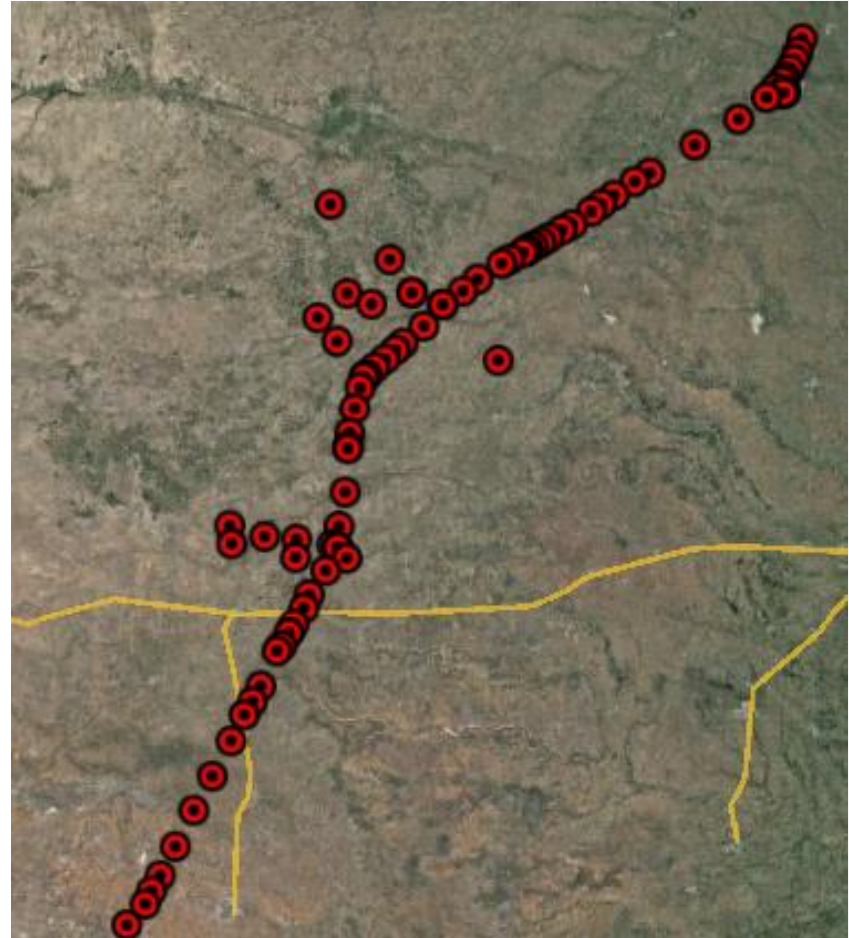## On Site vs Remote - **Periodic Inspection** Cost Analysis

Remote Monitor Inspection

- Annualized Cost for 66 Units

  - $36,055

    Includes

- 1/5th of Capital Investment

- Monthly Service Fee x 12

- Unit Replacement Costs
  - Reliability Factor 93.4
    - Equivalent to 4.4 units per year

  - Repair Time/Travel Cost

Case Study
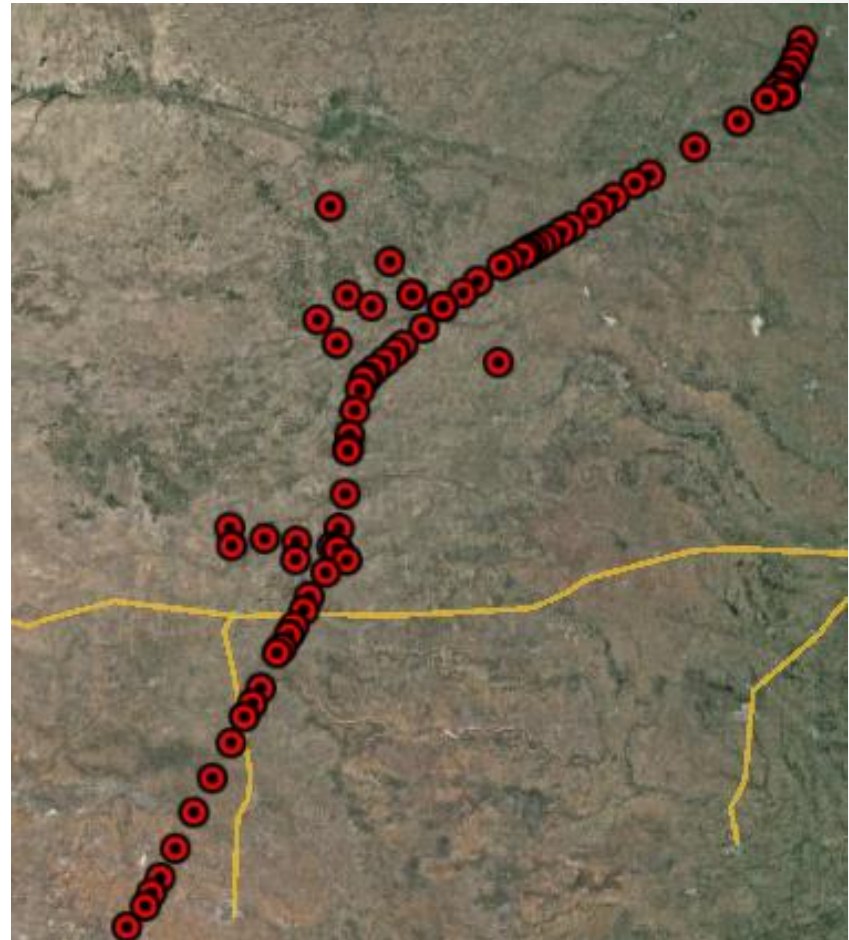## On Site vs Remote - **Periodic Inspection** Cost Analysis

On Site Inspection

- Annualized Cost/Site Visit (61)

    - X6 $ 505
    - X12 $1,010

Remote Monitor Inspection

- Annualized Cost/Remote Monitor (66)

    -                     $508

Case Study for Annual Survey
On Site vs Remote – **Interrupted Survey** Cost Analysis

On Site Interruption

Each current source should be visited prior to the Annual Survey

For an interrupted survey each current source will be visited twice

- Cost/Current Source (61)
    - Travel Costs $ 168
    - Current Interrupters* $ 118
    - x61 $17,466

*Cost of 20 portable interrupters annualized over 5 years

Case Study for Annual Survey
On Site vs Remote – **Interrupted Survey** Cost Analysis

Remote Interruption

Current sources can be confirmed to be operating via the website

Interruption can be started for all current sources via the website

- Cost/Current Source (61)
    - Transmissions $ 31
    - x61 $1,891

Case Study Result
On Site vs Remote – Annual Cost

On Site Cost

- Cost/Current Source (61)
    - 6 Periodic $ 505
    - Interrupted Survey $ 286

    - 12 Periodic $1,010
    - Interrupted Survey $ 286

- Case Study Annual Total
    - $48K - x6
    - $79K - x12

Remote Monitor Cost

- Cost/Current Source
    - Periodic $ 508
    - Interrupted Survey $ 31

- Case Study Annual Total
    - $35K

Annual Cost -27%

Other Considerations - **Periodic Inspection**

On Site Inspection

Pros

- On site visual inspection
- Routine cleaning and maintenance
- Repairs can be done while on site

Remote Monitor Inspection

Pros

- Reduces risk:
  - Driving to remote sites
  - Unsafe areas
  - Weather extremes
- Redirects time:
  - Reduces the process time to collect data
  - Allows more time to analyze data
  - Reduces the need for third party data collection (O&M, Contractor)

Other Considerations – **Inspection Data**

On Site Inspection

Pros

- Data recorded on site

Remote Monitor Inspection

Pros

- Data accuracy:

    - Redundant storage

    - Manual data entry can be eliminated

Monitoring Considerations – **Integrity of the CP System**

On Site Monitoring	Remote Monitoring
On Site Monitoring	*Remote Monitoring*
Pros	Pros
• On site visual inspection	• 24/7 Monitoring for the integrity of the CP System
	• An alarm is sent when output parameters are not met or exceeded
	• The data is readily available to the Technician
	• Current sources can be quickly verified prior to starting an annual survey

Annual Survey Considerations – **Current Interruption**

On Site Interruption

Pros

- On site visual inspection
- Routine cleaning and maintenance
- Repairs can be done while on site

Remote Monitor Interruption

Pros

- Multiple current sources can be interrupted from the website
    - Reduces the inventory of portable interrupters
    - Reduces the windshield time to deploy interrupters
    - Complete interruption requests from other companies

Inspection and Monitoring Considerations

On Site

Cons

- The current source can be off between visits
- Time and Travel required for periodic inspections
- Multiple site visits to set portable interrupters

Remote Monitor

Cons

- The initial cost of the equipment
- The maintenance or repair of additional equipment at a remote site
- Site visits to investigate alarms

Cost Control Considerations

- Model Evaluation
  - Match to application
    - Two Way Communication (Higher Capital Costs)
      - Monitor Alarms
      - On Demand Readings
      - Interruption Capabilities
    - One Way Communication (Lower Capital Costs)
      - Monitor Alarms
      - Scheduled Reading Transmissions

Cost Control Considerations

- <u>Billing Plans</u>

  - How many transmissions are needed per month

  - How many transmissions per plan

  - What is the cost per transmission over plan

Cost Control Considerations

- Monthly Cost Monitoring

  - Transmission Overages

    - Interruption Cycles

    - Alarms

  - Is there a monthly service charge for units not transmitting

    - Shelved Units

    - Units in for Repair

Cost Control Considerations

- <u>Inventory Controls</u>

  - Is there a need for spare units

  - Inventory Management

  - Damage Control

  - Monitor shelf life (battery, firmware)

Conclusions

- The Methodology developed represents an effective tool to evaluate the costs of On Site inspections and Remote Monitor inspections

- The Methodology revealed the need to consider additional factors for individual Case Studies

Questions/Comments