Energy Management Workshop

Kananaksis 2007

Eco-Efficiency Program

CETAC-WEST

Environment Canada Environnement Canada

Methane to Markets

PETROLEUM TECHNOLOGY ALLIANCE CANADA PTAC

Eco-Efficiency Program (Energy and Environment)

- Components
  - Integrated Plant Audits
  - Benchmarking
  - New Technology Demonstrations

Eco-Efficiency Program (Energy and Environment)

- Key Findings
  - Energy Management is good business
  - Economic benefits to industry
  - Environmental benefits for all

Integrated Plant Audit™

"A concurrent plant examination
by a
multidisciplinary team
of
leading industry experts,
to seek out economic and
environmental improvements."

The whole is greater than the sum of the parts

CETAC-WEST

Environment Canada Environnement Canada

Methane to Markets

PETROLEUM TECHNOLOGY ALLIANCE CANADA
PTAC

Integrated Plant Audit™

Energy

Feedstock

HCs, H_2S, CO_2

Product Streams

Gas

By-products

Condensate

S_X

Residual

Emissions
Liquids
Solid Waste
Heat Losses

CO_2, H_2O

Areas of Expertise

- Gas treating
- Dehydration
- Refrigeration
- Compression, Turbines and Pumps
- Sulphur Recovery, Incineration
- Electrical
- Combustion, Boilers, Utilities
- Fugitive Emissions

ENERGY MANAGEMENT WORKSHOP 2007

Integrated Audits

The Cream of the Audits

CETAC-WEST

Environment Canada

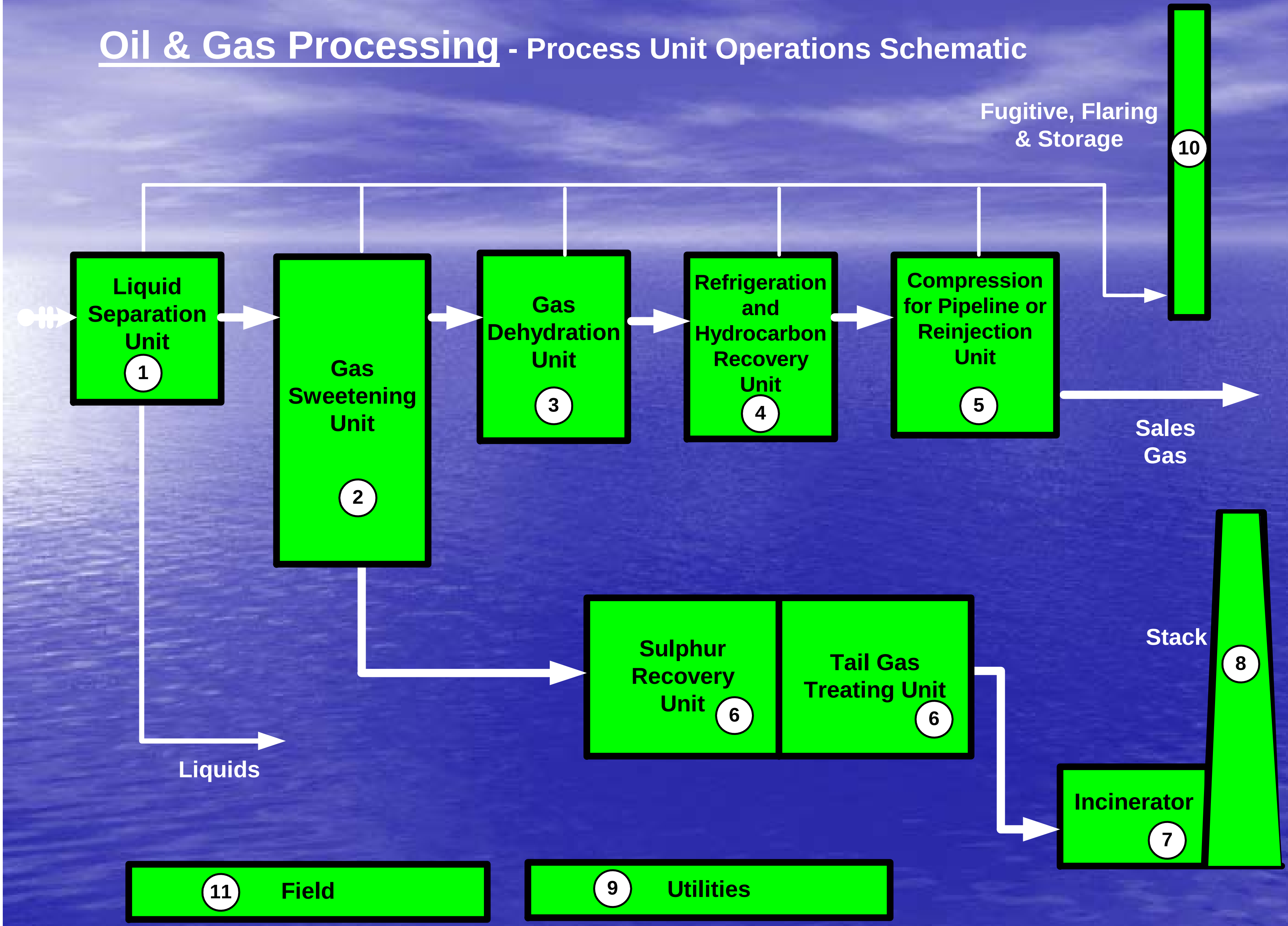
Environnement Canada

Methane to Markets

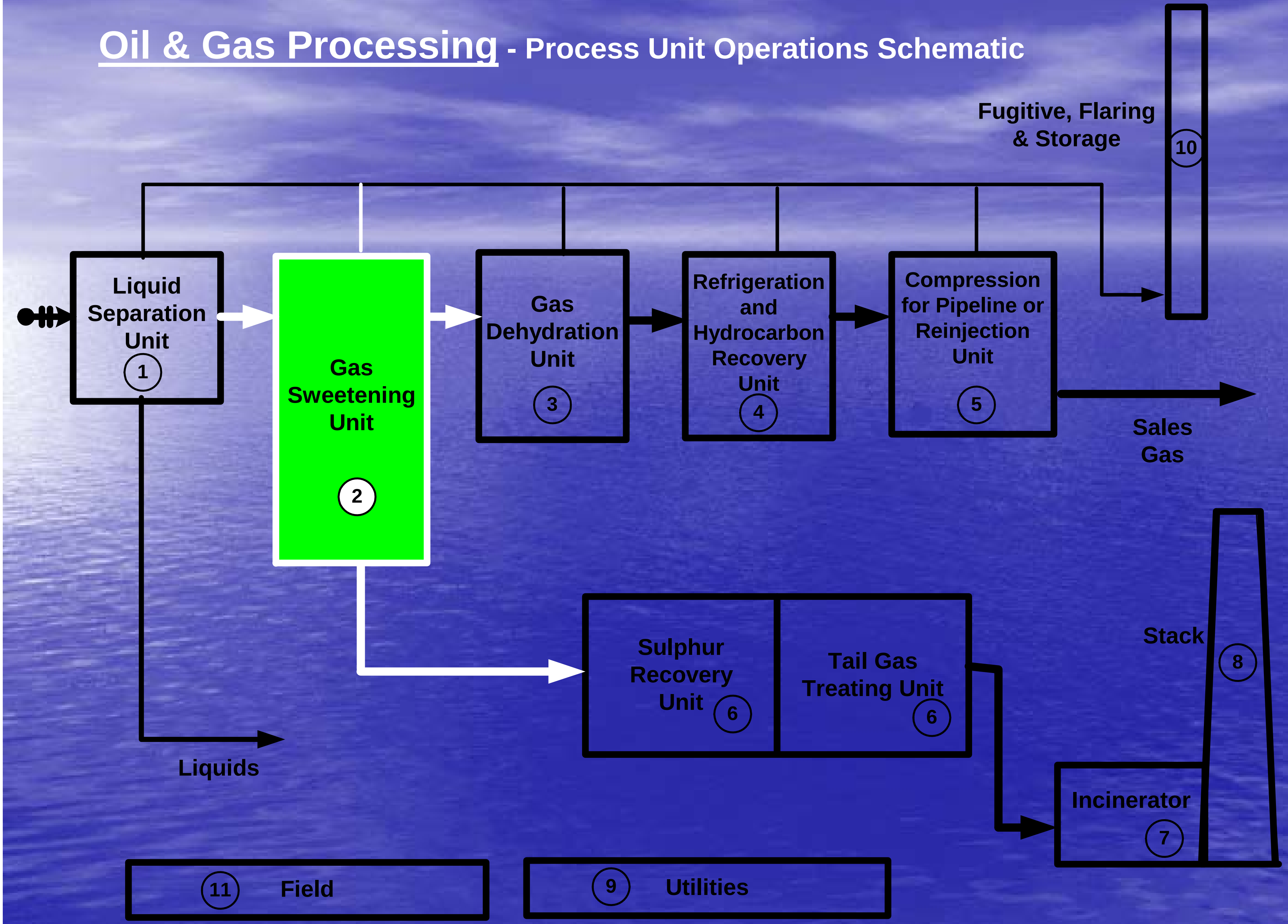
Petroleum Technology Alliance Canada

PTAC

Oil & Gas Processing - Process Unit Operations Schematic



Oil & Gas Processing - Process Unit Operations Schematic



ENERGY MANAGEMENT WORKSHOP 2007

Case Study

Bulk DEA Unit

Ben Spooner

Amine Experts Inc.

Bulk DEA Systems

- **HP System**
  - Single absorber operated at 590 psig to <4 ppm spec
- **MP System**
  - Single absorber operated at 235 psig to <10 ppm spec
- **LP System**
  - Single absorber operated at 125 psig to <10 ppm spec

Bulk DEA Systems

- Rich amine from all absorbers goes to common flash and then sent to a single regenerator
- Goal of audit is to optimize units so that energy costs are at a minimum and performance of absorbers and exchangers is more consistent

Operating Data

	HP FEED	MP FEED	LP FEED
H_2S	16.6921	29.9894	6.1281
CO_2	5.2833	6.4650	0.4348
COS	0.0030	0.0060	0.0025

- current HP flow is 61 MMSCFD
- original design flow to the HP absorber was 150 MMSCFD
- looking at a production decline curve of 14% per year
- equipment turndown issues at current and proposed rates
- **in-plant and third-party audits had already been undertaken - plant expected minimal energy savings from audit**

Plant Assessment

- Current performance corresponds to a rich loading of 0.532 mol/mol - room for optimization??
- Energy optimization in amine units is primarily achieved by a reduction in circulation rates

Recommendations for Optimization

- Combination of circulation rate reduction and solution strength increase (with an understanding of allowable rich solution loadings) is the basis for the audit team's recommendations for new operating parameters

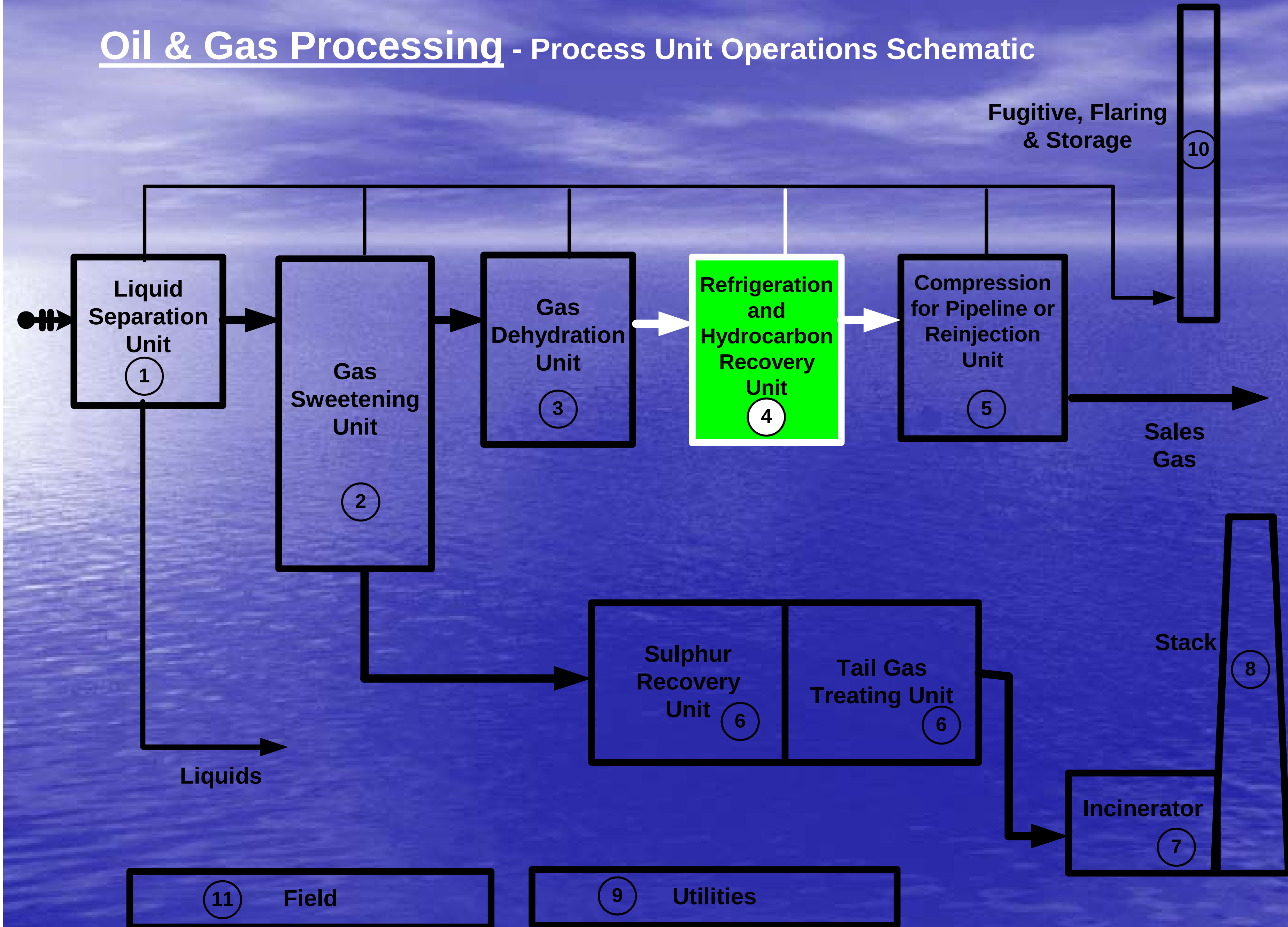
Optimization Steps

- Increase in amine strength from 28.5 wt% to 32 wt%
  - 12% reduction in circulation rate
  - leads to an expected reduction in steam of 18 600 lb/hr
- Further 7% reduction in circulation rate possible with increase in rich loading to 0.57 mol/mol (case sensitive)
- Expected additional steam savings of 8 700 lb/hr for a total savings of 27 300 lb/hr

Result of Changes

- No equipment changes; no new equipment
- After making suggested circulation rate reductions and strength increase, the plant reported the following improvements
  - Steam reduction from 126 000 to 111 000 lb/hr – estimated savings of >$500 000/yr
  - Treated gas H_2S specification consistently lower than historical

Oil & Gas Processing - Process Unit Operations Schematic



ENERGY MANAGEMENT WORKSHOP 2007

Case Study

Two Technologies

- Single Objective

Neil Franklin, P.Eng.

Tartan Engineering Ltd.

CETAC-WEST

Environment Canada Environnement Canada

Methane to Markets

PETROLEUM TECHNOLOGY ALLIANCE CANADA PTAC

What Makes This Case Study Interesting?

- Multiple Technologies
  - Combining technologies for a single result
- Potential for Synergies
  - Energy savings through unit integration
- Trade-off of Different Energy Forms
  - Energy consumption, high and low unit energy costs

Situation

- LPG recovery by
  - Propane Refrigeration and Lean Oil Absorption
    - Typically use either, rarely use both
- Propane condensing by two technologies
- Two forms of energy use
  - 1300 hp (Refrigeration) + 37 MMBTU/hr (Absorber)
  - $3 million/year

Audit Findings

- Plant running at 1/3 of design feed
  - Equipment oversized
- Opportunities to improve refrigeration Coefficient of Performance
  - Minimize compressor discharge in winter
  - Add economizer
- Poor efficiency in Lean Oil Absorber
  - Lean Oil composition too vague
  - Tray type? Tray damage?
  - Poor gas/liquid distribution?

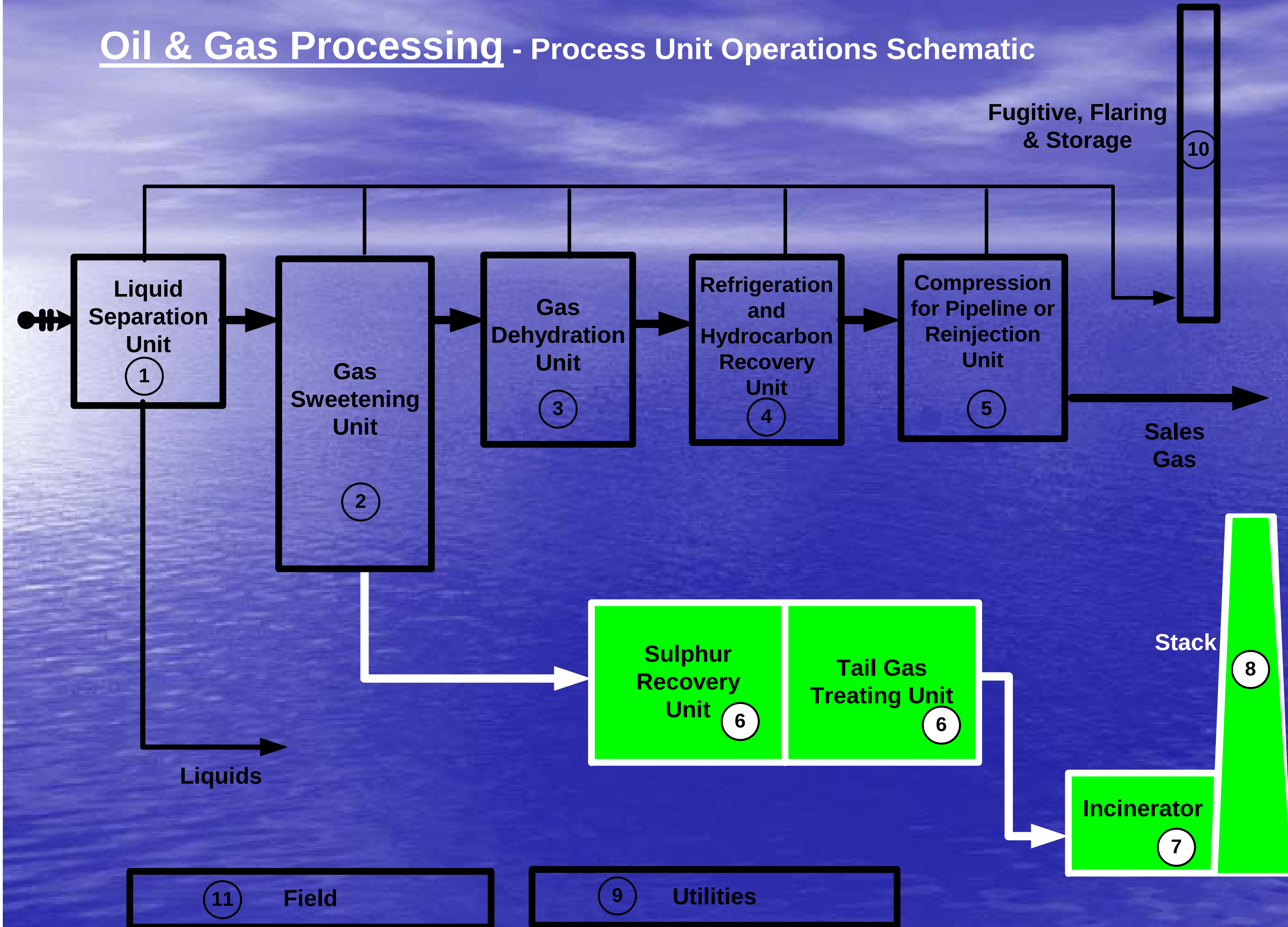
Opportunities

- Optimize individual units and **combined** operation of Refrigeration Unit & Lean Oil Absorber
  - Lower Chiller temperatures in Refrigeration Unit
  - Reduce lean oil circulation rates
- Achieve overall energy savings of $1 million/year (33%)
  - Use electrical energy more effectively to save fuel use
  - 1/3 of savings through unit integration synergy
- Small capital investment
  - Economizer
  - Absorber internal/packing

Follow-Up Actions

- Confirm the opportunities
  - Computer simulation to confirm current and predicted operation
- Engineering design of required modifications
- **Update operating procedures to reflect new situation**

Oil & Gas Processing - Process Unit Operations Schematic



ENERGY MANAGEMENT WORKSHOP 2007

Case Study

SRU Incinerator

Jamie Swallow

Sulphur Experts Inc.

CETAC-WEST

Environment Canada Environnement Canada

Methane to Markets

PETROLEUM TECHNOLOGY ALLIANCE CANADA

PTAC

Tail Gas Incineration

- Sulphur Recovery Efficiency higher than licensed value (98.7 vs. 98.0)
- Still room to improve recovery efficiency (>99%)
- Considerable room to reduce fuel gas consumption by Tail Gas Incinerator

Sulphur Recovery Unit Findings

- Sulphur Recovery performance impacted by COS and CS_2 losses
- Attributed to partial deactivation of catalyst in first stage

Tail Gas Incineration Findings

- Attainment of Total Reduced Sulphur destruction requires high excess oxygen
- Stack top temperature is much higher than current sulphur inlet loading requires
- One third of the energy available in the tail gas stream is not being utilized in the incinerator

Tail Gas Incineration Analysis

- Incinerator performance is constrained by Total Reduced Sulphur destruction despite high oxygen level and high operating temperatures
- Lower Stack Top Temperature will not result in ground level SO_2 excedences
- Performance is indicative of poor mixing of the tail gas within the incinerator

Recommendations - SRU

- Replace catalyst in first converter using titania-based technology to assist COS and CS_2 hydrolysis

Recommendations - Tail Gas Incinerator

- Replace existing natural draft burners with a high-intensity forced draft burner
- This will:
  - Improve mixing
  - Allow lower excess oxygen
  - Utilize energy from Tail Gas stream

Recommendations - Tail Gas Incinerator

- Apply for a tiered license based upon sulphur inlet loading
- This will:
  - Allow Stack Top Temperature to be reduced and more closely match Total Reduced Sulphur destruction required

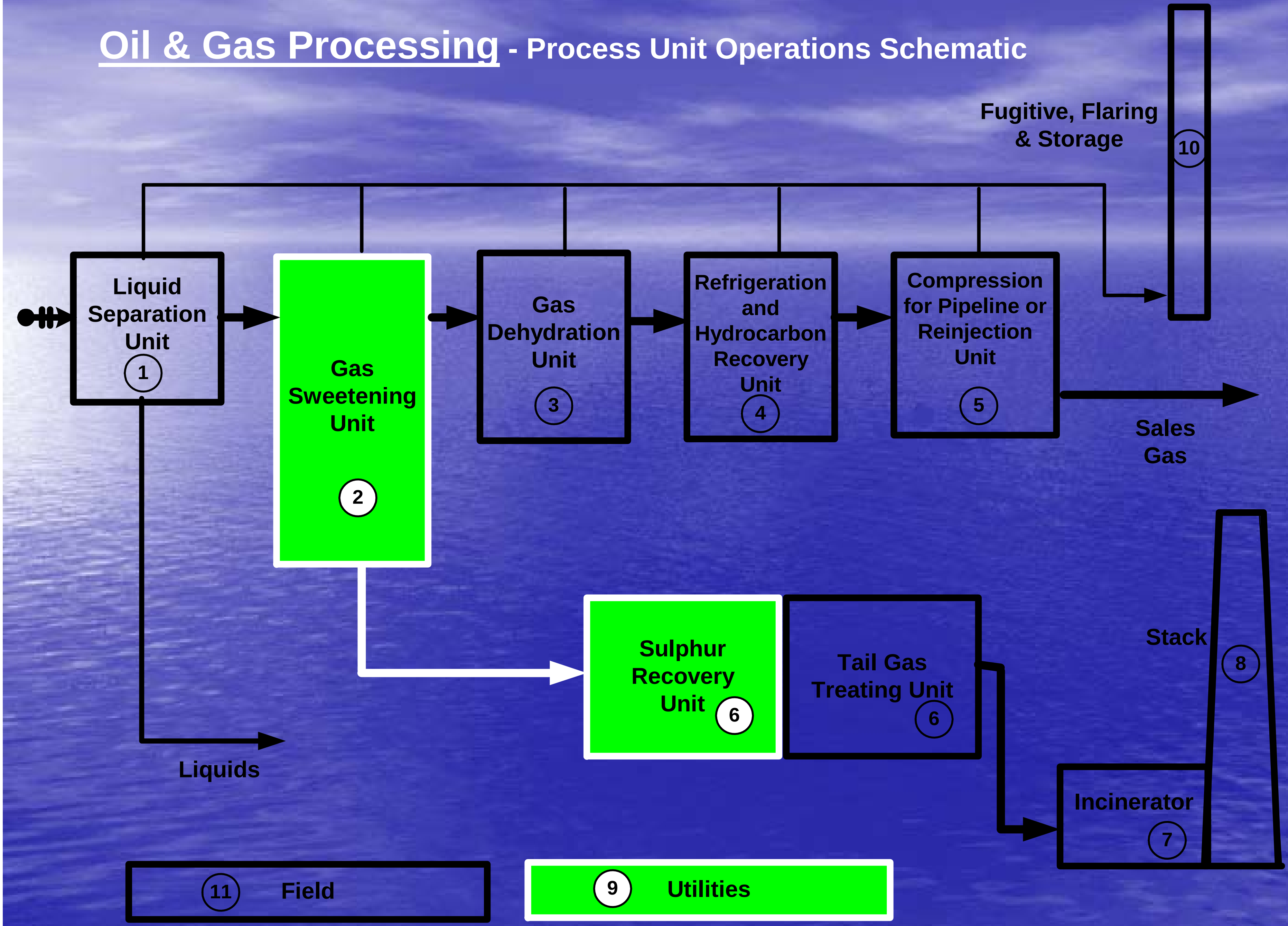
Projected Energy Reductions

- Incinerator fuel gas can be reduced by 48% in total
- This will be achieved by:
  - Improved mixing – 22%
  - Lower excess O_2 - 9%
  - Lower Stack Top Temperature – 17%

Economic and Environmental Impacts

- Reduced Fuel Gas - $1 million
- Reduced CO_2 (GHG) - >8 million tonnes

Oil & Gas Processing - Process Unit Operations Schematic



ENERGY MANAGEMENT WORKSHOP 2007

Case Study

Steam Plant Optimization

Nev Hircock
Process Consulting Ltd.

Steam Case Study Economics

- At design a sulphur plant generated 50 MMBTU/hr exothermic steam at 250 psig and the amine plant utilized 40 MMBTU/hr at 50 psig
- Back pressure steam turbines generated 1000 hp and an excess steam condenser balanced out the 10 MMBTU/hr difference

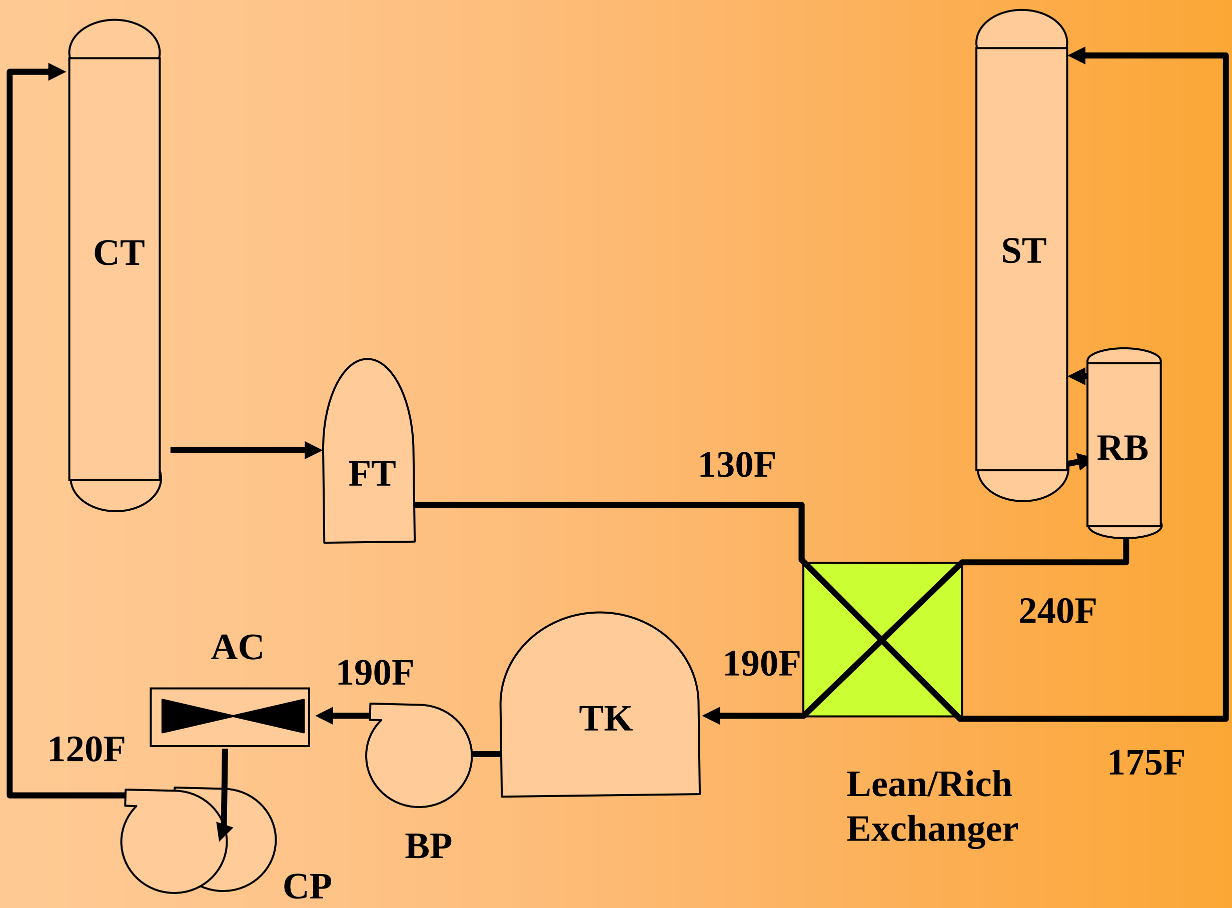
Steam Case Study Economics

- 30 years later, the sulphur plant now makes only 20 MMBTU/hr and the amine plant needs only 20 MMBTU/hr
- In order to keep the steam turbines running, they need 30 MMBTU/hr of steam from the auxiliary boiler
- The auxiliary boiler needs to be retired or replaced

Steam Case Study Economics

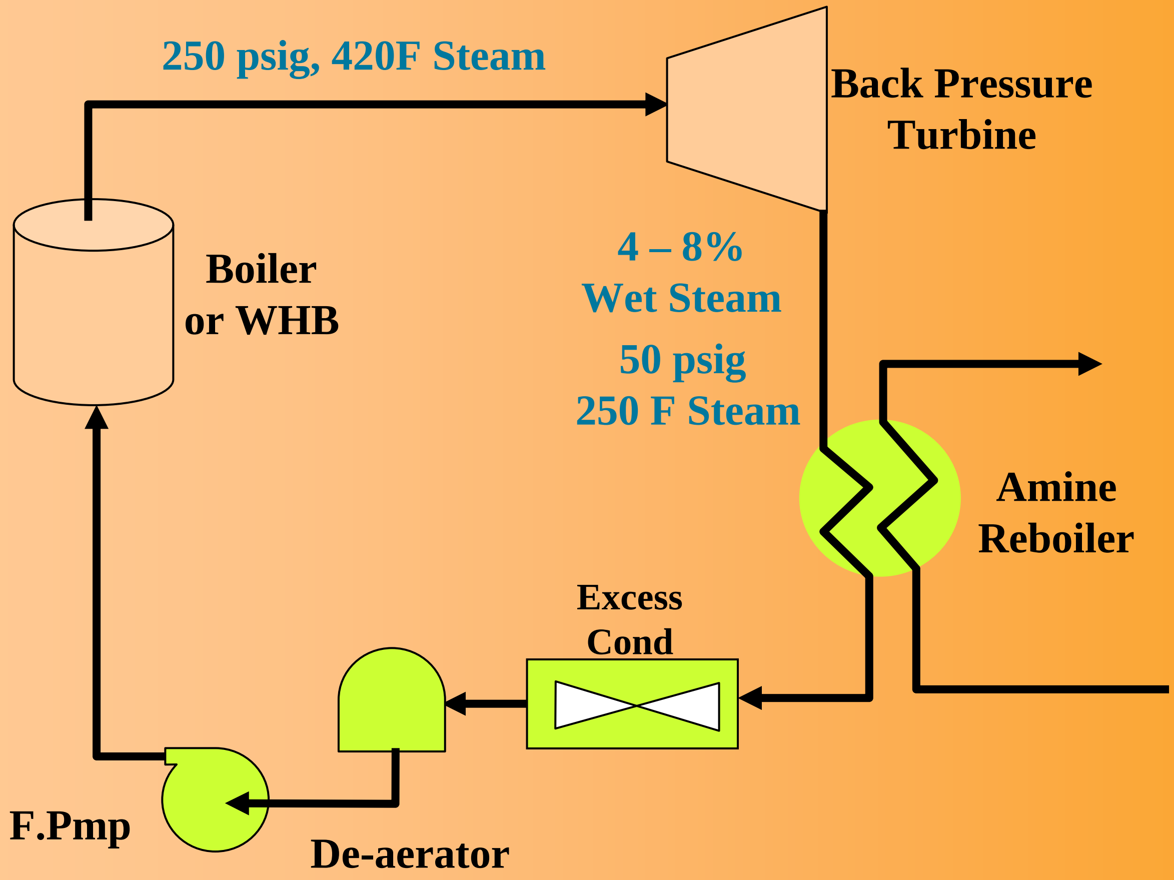
- This is a common problem faced by older sulphur recovery plants when the exothermic aspect of the sulphur plant is no longer sufficient to meet the steam turbine requirements

Amine Plant

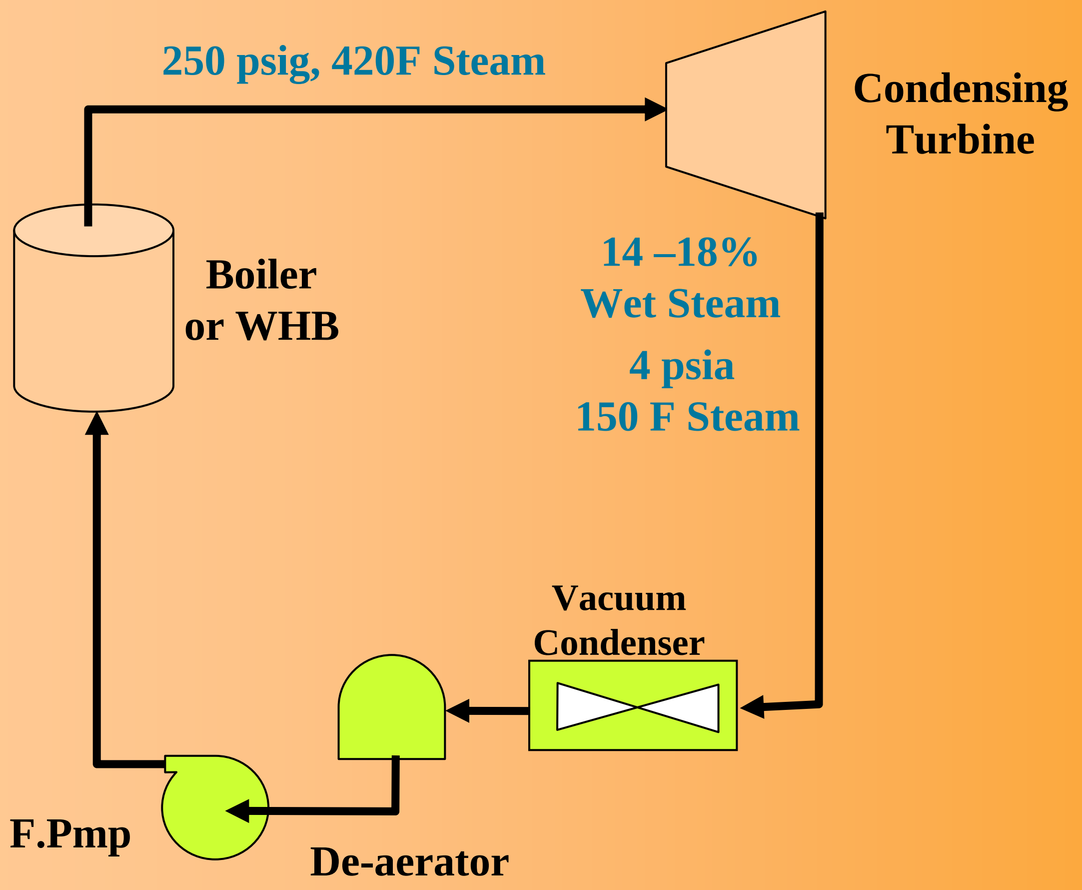


CT
ST
RB
FT
130F
240F
AC
190F
190F
TK
120F
175F
Lean/Rich
Exchanger
BP
CP

Back-Pressure Turbine



Condensing Turbine



- When the plant was built, the steam turbines were a good choice since the sulphur plant produced steam at 250 psi but the amine plant only required steam at 50 psi
- Taking the pressure drop across a turbine produces essentially free energy

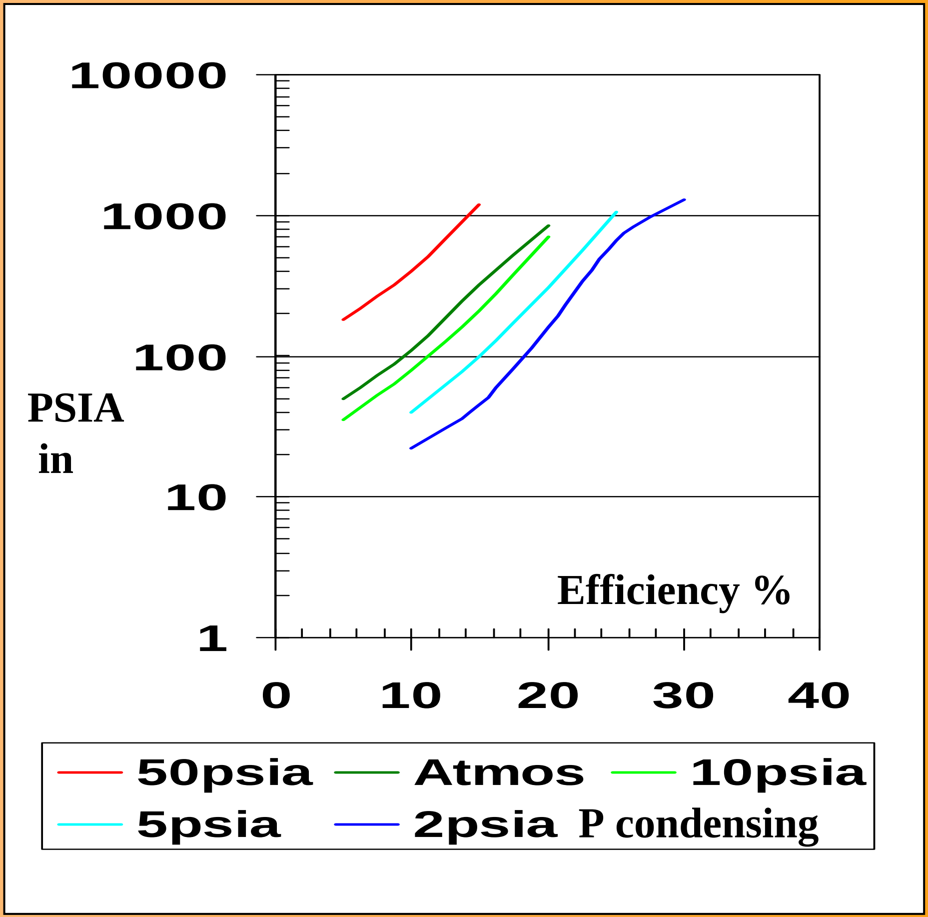
Steam Case Study Economics

- Available Options:
  - Install a new auxiliary boiler and install an extra 30 MMBTU/hr of excess steam condenser.
  - Install the new auxiliary boiler and over-circulate the amine by a factor of 2 to condense the excess steam.
  - Scrap the steam turbine, install 1000 hp of electric motors and let the sulphur plant balance the amine plant steam requirements.

Steam Turbines

- Back pressure turbines are very inefficient (<15%) unless the exit steam is used for heat transfer.
- Condensing turbine efficiency can be quite good (>35%)

  …IF the steam pressure is very high and superheated and condensing pressure is very low.



Steam Case Options

	Action:	Capital Cost $k	Annual Operating Cost $k	3 Year Combined Cost $k
1	**Add Auxiliary Boiler and Excess Steam Condenser**	1500	1650	6450
2	**Add Auxiliary Boiler and over circulate Amine**	900	1860	6480
3	**Remove Steam Turbines and install electric motors**	60	390	1230

Assumptions: **Fuel @ $6 per MMBTU**
Electricity @ 6c per kWh

Conclusions

- When process conditions change, the original design may no longer be appropriate
- Continuing to operate “the way we always have” can be an expensive option
- The cost of fuel gas must be considered in evaluating alternatives

ENERGY MANAGEMENT WORKSHOP 2007

Case Study

Energy Management

Brian Tyers

Stantec Consulting

CETAC-WEST

Environment Canada Environnement Canada

Methane to Markets

PETROLEUM TECHNOLOGY ALLIANCE CANADA PTAC

Case Study

Gas Plant Facility in Central Alberta

- Background
  - Fuel use cycling up
  - Electrical use steady
  - Production cycling down

- Energy audit and conservation initiatives implemented
  - **Energy Reduction of 15%**
- **But**
  - No system established / installed to monitor and target the energy use relative to production

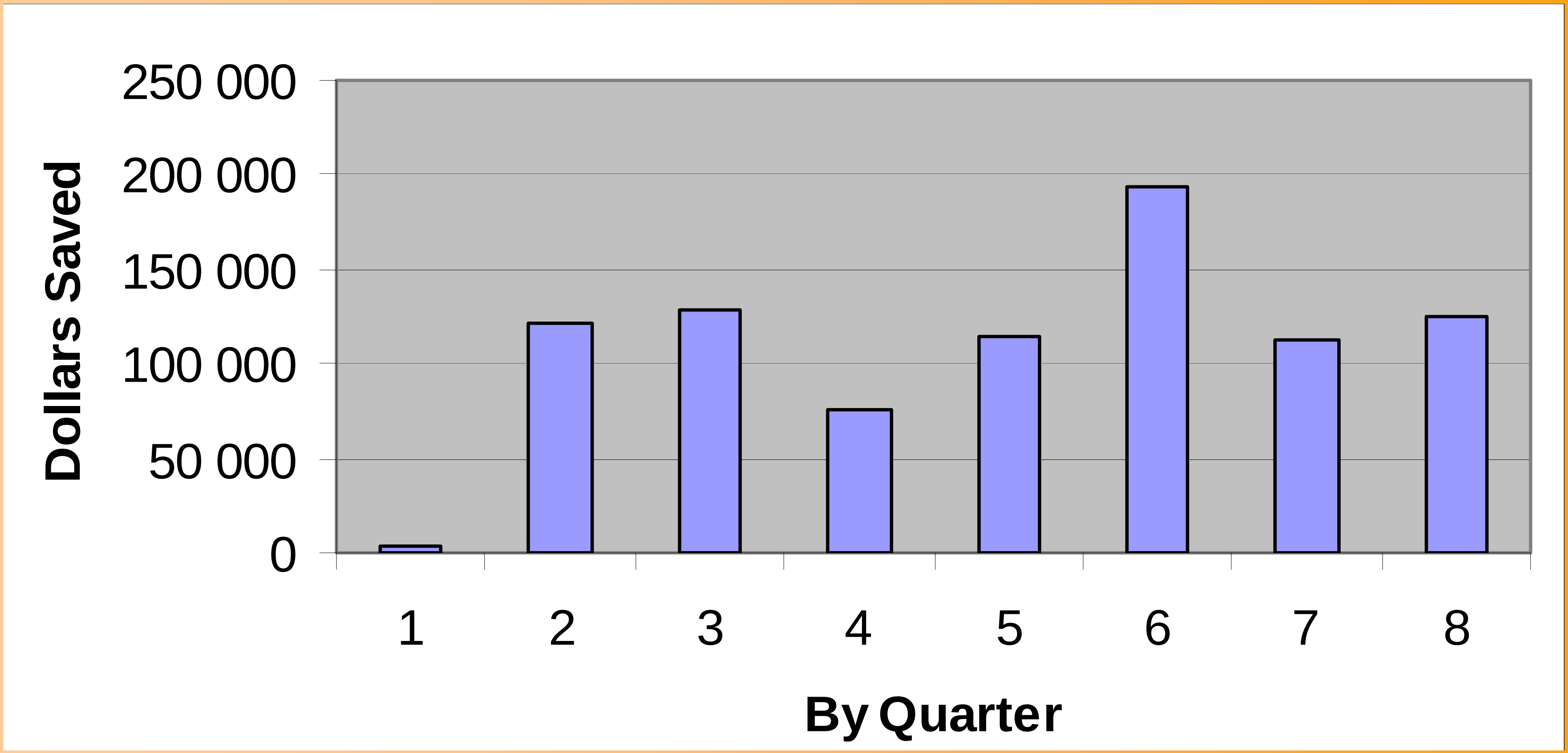
Set Up

- Energy Champion appointed – Plant Lead Operator
- CUSUM introduced and steps performed:
  - Data collection (production, fuel gas, electricity)
  - Baseline selection
  - Correlations for predicting energy use variation
  - Estimate of difference in energy use
  - Cumulative summation of differences

Actions

- Energy Champion
  - Recorded readings daily (part of existing log reporting)
  - Looked for changes in direction (~10 minutes per day)
  - Consulted with operating staff (part of daily meeting)
    - Determined what caused the change
    - Eliminated improper actions
    - Replicated beneficial actions
  - Communicated results

Savings by Quarter



Summary

- **Significant economic savings**
  - Identified energy savings were **9-20% ($400 to $900K)** compared to baseline performance
  - **Cost to Implement - $20,000 plus noted Lead Operator time**

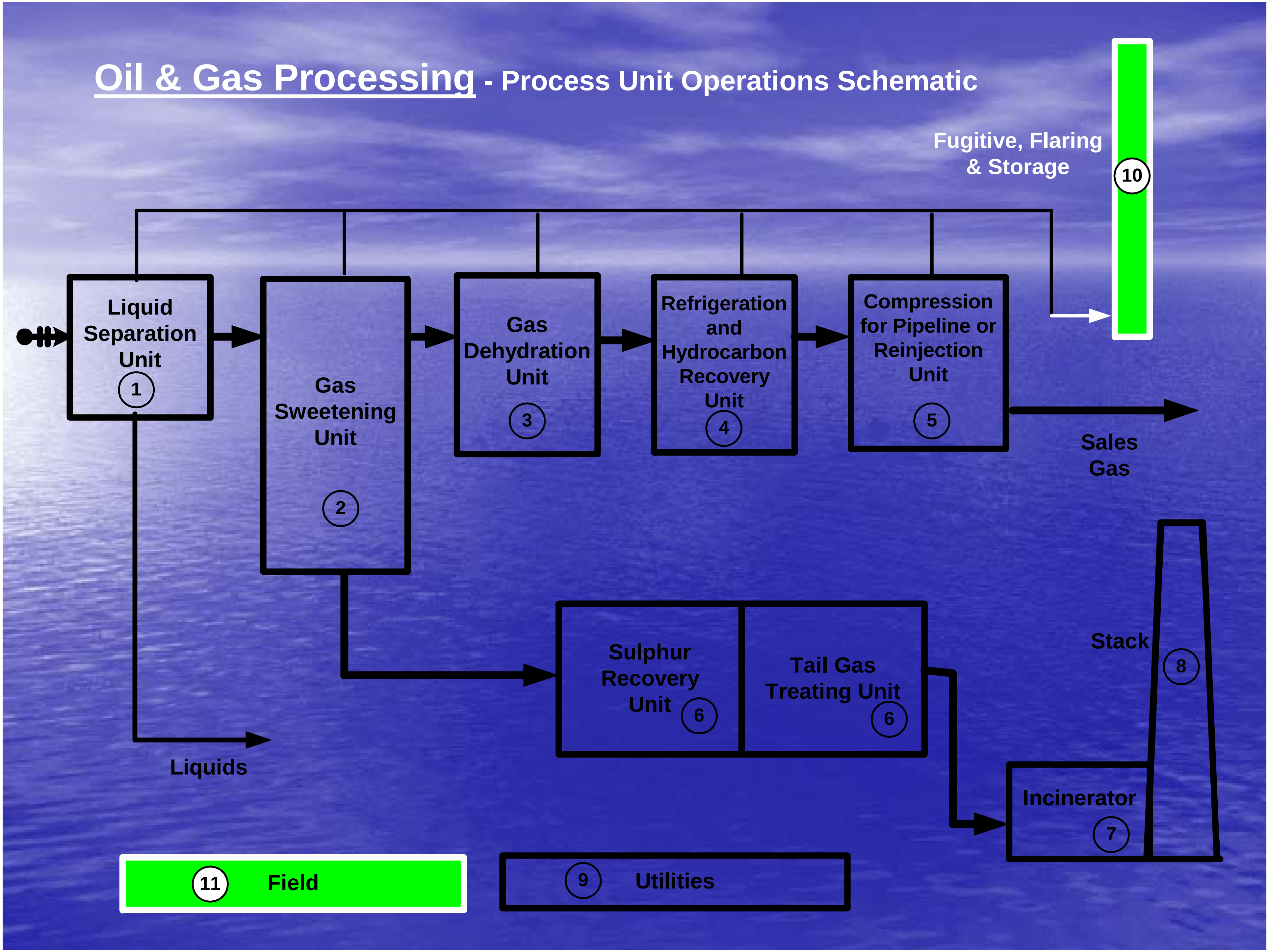
- **Simple Payback: 1.2 to 2.6 weeks**

Summary

- **Greater retention of savings**
  - Lack of M&T can erase energy management gains
  - CUSUM can hold, **and extend**, those gains
- **Greater ability to deal with 2 significant problems for Western Canadian operations**
  - Changing throughput
  - Extremes of climate
- **Need to periodically update baseline**

Summary

- **Change in operator view of energy management**
- **Before**
  - Energy consumption is inevitable…
    - What can **We** do about it?
- **Now**
  - We can make a difference…
    - **We** can reduce our energy use.
  - Selling concept to Field Operators


Oil & Gas Processing - Process Unit Operations Schematic
Fugitive, Flaring & Storage
10
Liquid Separation Unit
1
Gas Sweetening Unit
2
Gas Dehydration Unit
3
Refrigeration and Hydrocarbon Recovery Unit
4
Compression for Pipeline or Reinjection Unit
5
Sales Gas
Stack
8
Sulphur Recovery Unit
6
Tail Gas Treating Unit
6
Liquids
Incinerator
7
11
Field
9
Utilities

ENERGY MANAGEMENT WORKSHOP 2007

Case Study

Fugitive Emission Reduction Opportunities

Marline Smith

Clearstone Engineering Ltd.

CETAC-WEST

Environment Canada Environnement Canada

Methane to Markets

PETROLEUM TECHNOLOGY ALLIANCE CANADA PTAC

Why Target Natural Gas Losses and Fugitive Emissions?

- Sensible means of reducing greenhouse gas (GHG) emissions in a transparent and verifiable manner
  - Cost-effective control opportunities based on value of saved gas
  - Typically low capital cost of controls
    - **"Low hanging fruit"**
  - High GHG intensity
    - **Global warming potential CH_4 = 21.0 * CO_2**
  - Measurement of baseline GHG emissions – may become important for GHG trading programs

Facility Description

- **Sour compressor facility**
  - continuously manned
  - 1 turbine compressor
  - 5 reciprocating compressors
  - 2 dew point control trains
  - 2 flare systems

  - Equipment components surveyed: 5 471

Emission Survey Findings

- Fugitive emissions
  - **84 leakers identified, 25 cost-effective repairs**
  - **3 largest leakers – 3 170 x 10^3 m^3/yr in losses**
    - recip. start gas vent $587 000/yr
    - packing case vent $ 82 000/yr
    - packing case vent $ 75 000/yr
  - **Total identified losses: 3 200 x 10^3 m^3/yr**
  - **Fugitive GHG emissions: 43 600 tonnes CO_2E/yr**

Emission Survey Findings

- Flared gas
  - Excessive flaring observed
    - blowdown valve partially open
    - Source eliminated during visit

- **Potential savings for site:**
  - **GHG emissions 43 500t CO_2E/yr**
  - **Avoided natural gas losses $ 755 000/yr**
  - **99% of emissions avoidable at NO NET COST**

Recommendations & Deliverables

- Recommendations:
  - Undertake cost-effect repair opportunities
  - Install flow indicators on compressor vents – early detection of leakage problems
  - Install monitoring ports on flare system – periodic checks for leakage into flare header
- Deliverables:
  - Ranked listing of identified control opportunities
  - Cost-curve for reduction of natural gas losses
  - Baseline emissions inventory

Emission Reduction Opportunities:
KEY FEATURES

- Opportunities greatest at older and un-manned facilities
- Lack of reliable visible or audible indicators
- Emissions occur at elevated or difficult to access locations
- Lack of measurement data
- Typically 70-80% of fugitives are cost-effective to control (less than 1 year paybacks)
- **Most fugitive emissions result from fewer than 10 sources per site**

In conclusion…

- Significant financially attractive opportunities to control natural gas emissions do exist
  - Can be overlooked or understated in absence of reliable measurement or estimation results
- Opportunities would not be quantified without an audit
- Fugitive emission reduction opportunities are worth pursuing from a GHG perspective
  - High GHG intensity of CH_4

Integrated Plant Audit

Requires:

- Unit by unit expertise
- Multi-disciplinary approach
- Concurrent effort