Preparing Amine, Acid Gas and Sour Water Vessels for Safe Entry with the Vapor-phase Application of an Organic Solvent and Pyrophoric Oxidizing Agent

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REFINED technologies

Agenda

- Objectives of prepping equipment for maintenance
- Traditional methods of cleaning equipment
- Pros and cons of traditional methods
- Vapor-phase application of organic solvent + pyrophoric treatment
- Summary of cleaning and treating steps
- Dealing with solids and sludge in amine and sour water equipment
- Example overviews
- Typical timeline
- Results
- Breadth of RTI applications
- Summary

Cleaning Objectives

Following are typical objectives for cleaning projects:

- Create a safe environment for workers: No LEL readings, No H2S, No hydrocarbon incl. Bz, No pyrophoric substances
- Minimize or eliminate spading under fresh air – time, risky and $$
- Maintenance activities begin on time – predictable start = $$
- Maintenance activities not interrupted
- Minimize mechanical requirements of the cleaning project
- Minimize amount and toxicity of effluent to be processed

Traditional cleaning methods

The systems in question historically are cleaned for entry using the following methods:

- High-volume water flushes
- High-volume circulation with surfactants
- Fill and soak with chemicals
- Weak acid wash followed by neutralization
- Vapor phasing a solvent/water mixture
- Liquid treating of pyrophoric material

Pros and Cons of Traditional Methods

- Pros:
  - Low cost
  - Familiarity with the processes

- Cons:
  - Slower than vapor-phased organic solvent
  - Higher volume of effluent generated
  - Disposal of toxic and or hazardous effluent
  - More equipment intensive

Vapor-phase solvent and treatment solution

- RTI began cleaning with fully organic solvents in 2000.
- The solvent, QuikTurn®, is vaporized by steam or hot nitrogen.
- The vapor-phase application removes all hydrocarbon from internal surfaces. Equipment is ***clean***, not just de-gassed.
- Immediately following the cleaning process, an oxidizing agent, Quench® is injected with steam to treat pyrophoric materials.
- The result>>> All equipment will be hydrocarbon free, free of toxic gases and pyrophoric substances oxidized; a safe system for maintenance work.

Summary of the Process

Following are the typical cleaning/treating steps after system is taken off-line:

1. Amine vessels are rinsed with clean water to ~9pH and drained.
2. Steam is applied to raise temperature to >110°C, venting through towers/accumulators to the flare. Low point drains are kept dry.
3. Inject solvent over a 1-3 hour period.
4. Inject oxidizer over a 20-60 minute period.
5. After ~2 hours, remove steam and change vapor space to nitrogen or atmosphere.
6. Once towers are cool enough, rinse with clean water, top down, in order to remove hydrocarbon on horizontal surfaces.

Dealing with sludge and solids

- Often, amine and sour water systems contain solids/sludges in the bottom of vessels. These materials must be agitated for proper removal of contaminants and treatment of pyrophorics.
- The “rumbling” technique works well to agitate the solids/sludges and allow chemicals to work as designed.
- The rumble technique:
  - Add a level (.5-1m) of cool water to the vessel bottom.
  - Add a prescribed amount (100-400 L)of solvent to the water.
  - Agitate with steam for a period of time, ~15-30 minutes.
  - Empty the vessel and if badly fouled, repeat.
  - Rinse out solids
- After the rumble step, proceed with the vapor-phase cleaning.

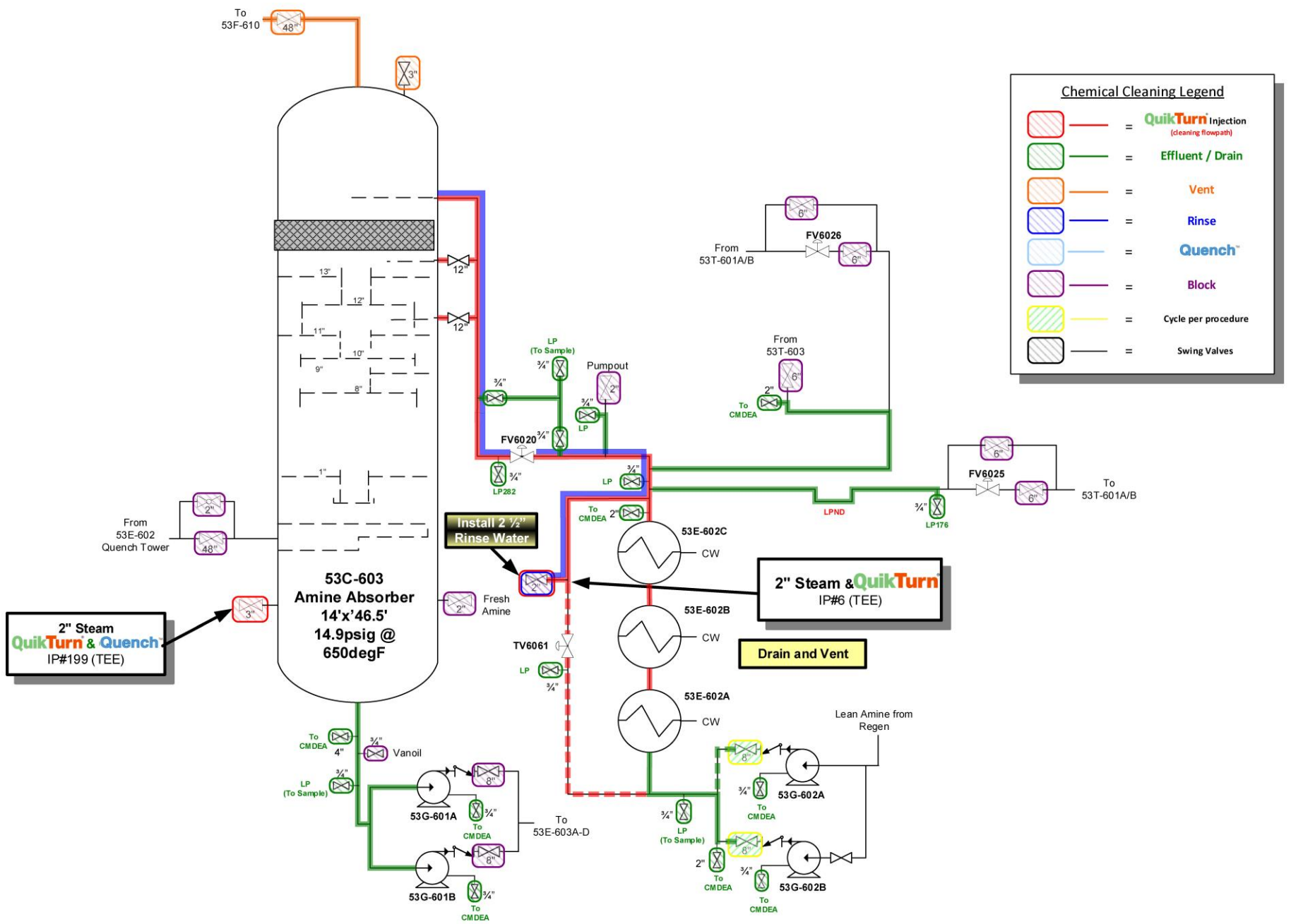
Examples

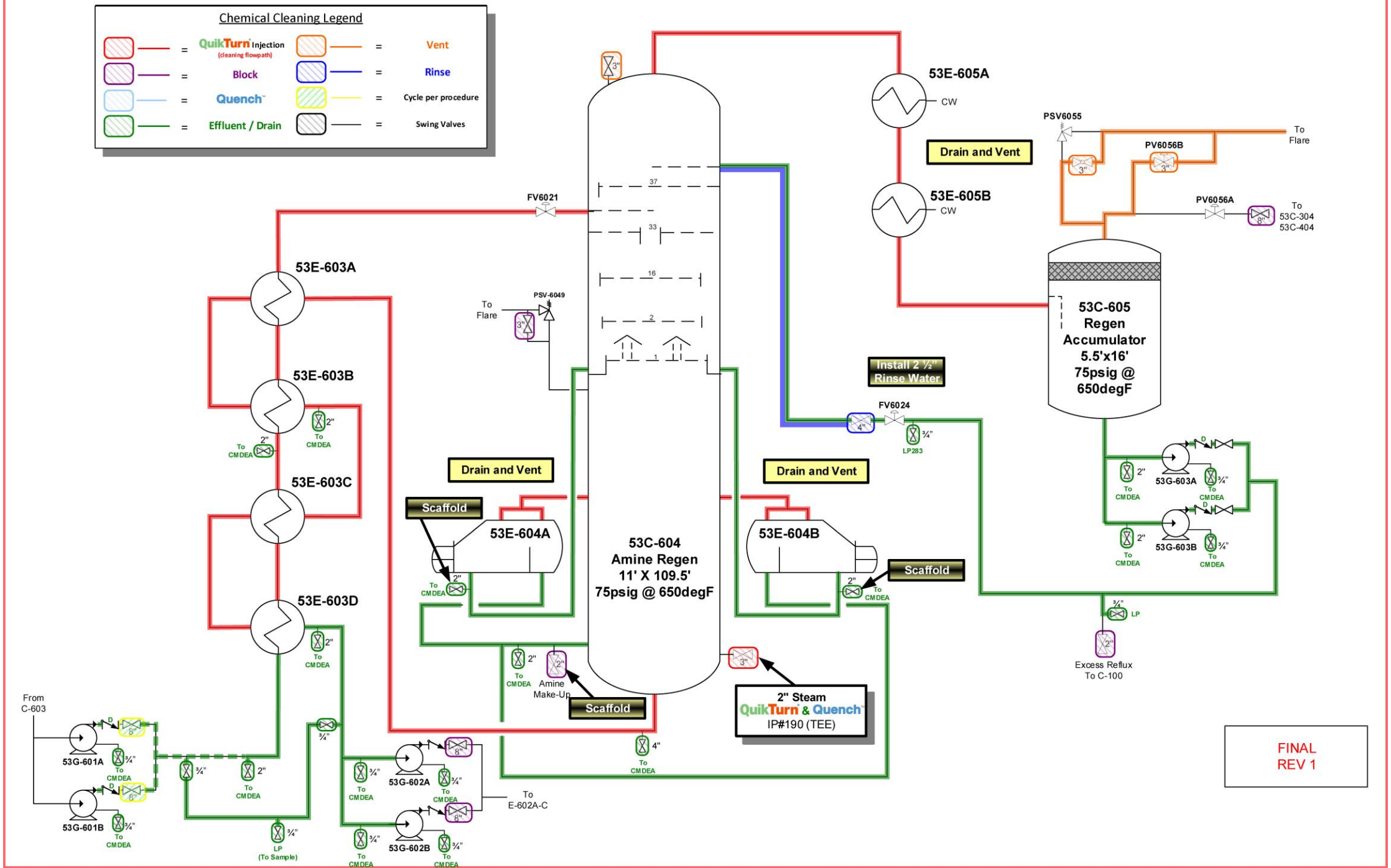
Amine Absorber

Amine Regenerator

Amine Flash Drum

Sour Water Stripper




Chemical Cleaning Legend
QuikTurn Injection (cleaning flowpath)
Block
Quench
Effluent / Drain
Vent
Rinse
Cycle per procedure
Swing Valves
53E-605A
CW
53E-605B
CW
Drain and Vent
PSV6055
PV6056B
PV6056A
To Flare
To 53C-304 53C-404
FV6021
53E-603A
53E-603B
53E-603C
53E-603D
PSV-6049
To Flare
53C-605 Regen Accumulator 5.5'x16' 75psig @ 650degF
Install 2 ½" Rinse Water
FV6024
LP283
Drain and Vent
Drain and Vent
Scaffold
53E-604A
53E-604B
Scaffold
53C-604 Amine Regen 11' X 109.5' 75psig @ 650degF
Amine Make-Up
Scaffold
2" Steam QuikTurn & Quench IP#190 (TEE)
53G-603A
53G-603B
LP
Excess Reflux To C-100
From C-603
53G-601A
53G-601B
53G-602A
53G-602B
To E-602A-C
LP (To Sample)
To CMDEA
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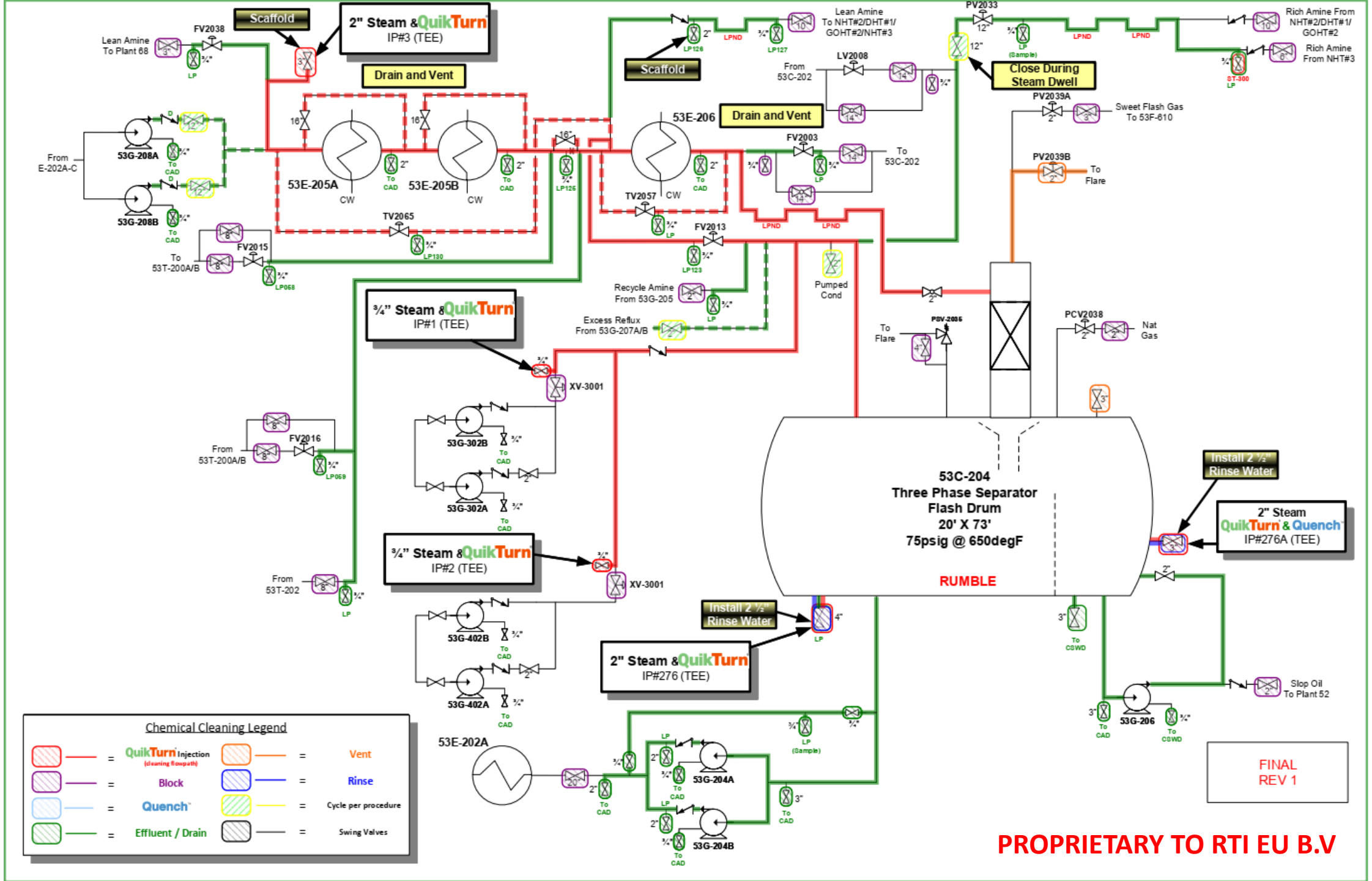
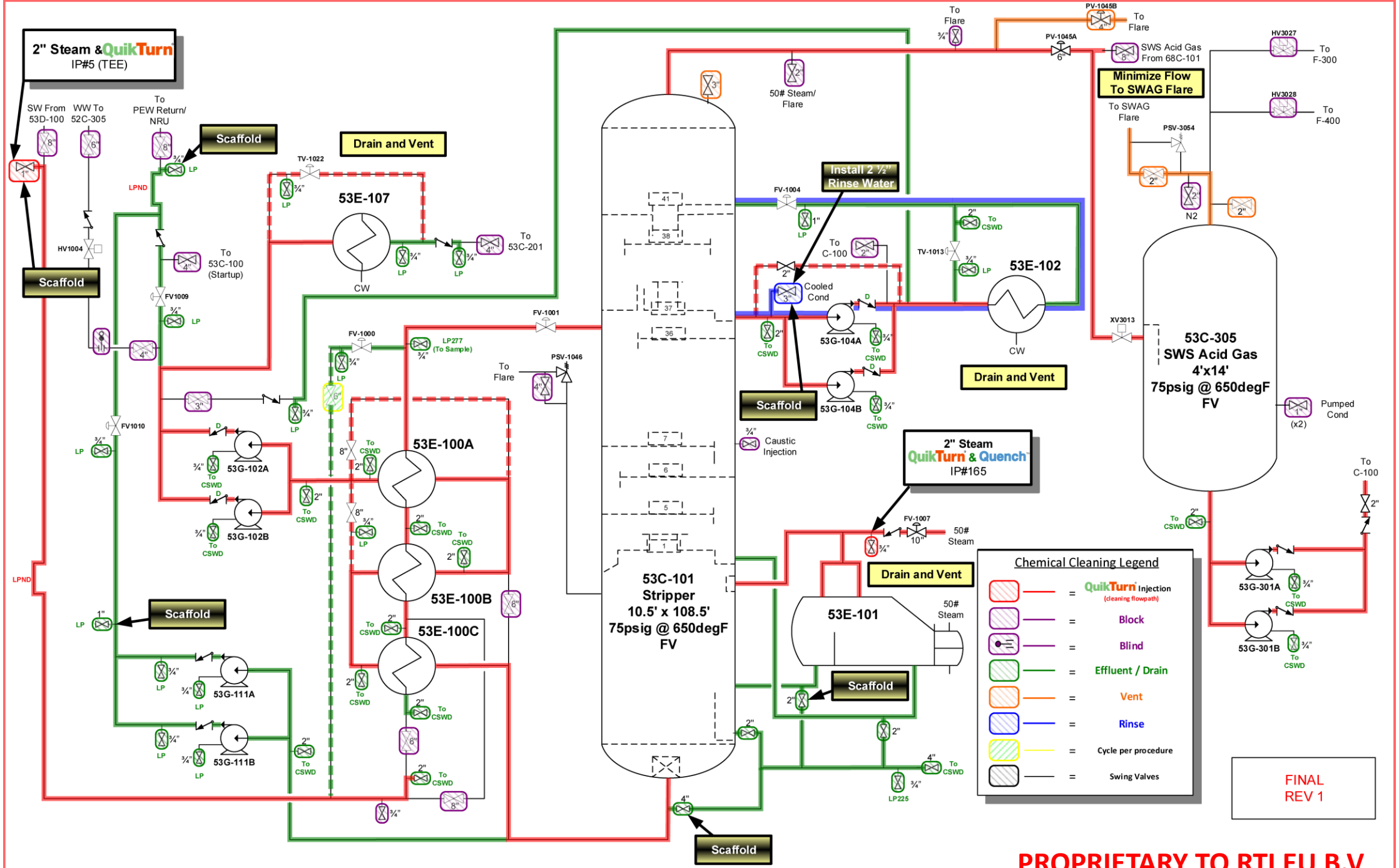
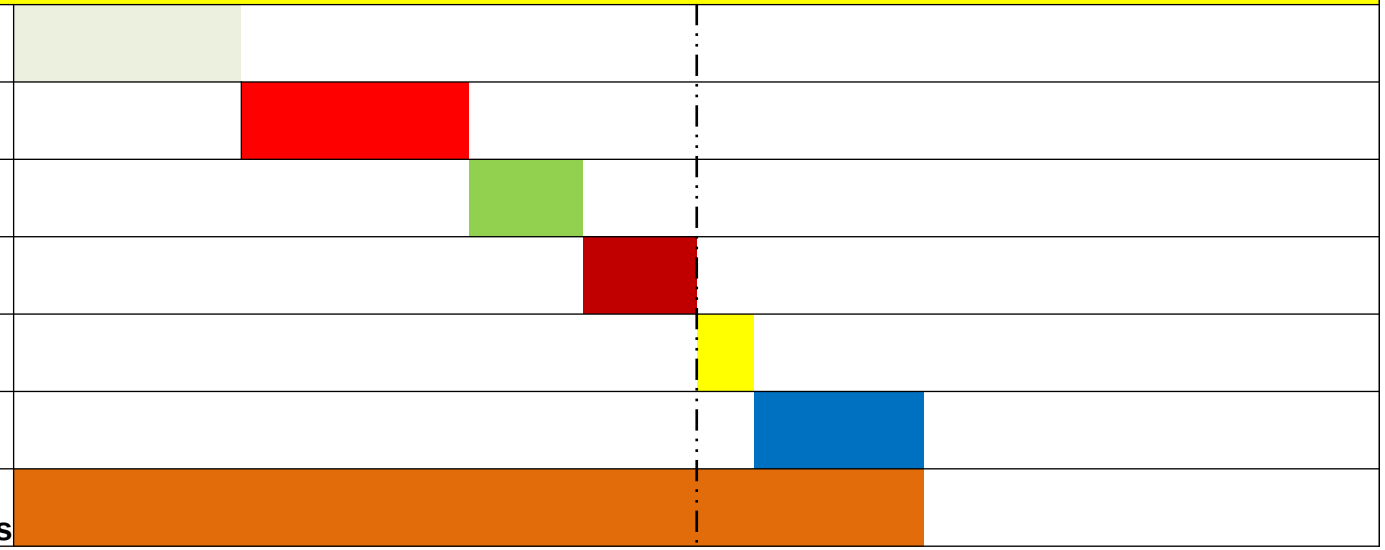

Scaffold
2" Steam &QuikTurn
IP#3 (TEE)
Drain and Vent
Lean Amine
To Plant 68
FV2038
LP
From
E-202A-C
53G-208A
53G-208B
To
CAD
53E-205A
53E-205B
CW
TV2065
LP130
FV2015
To
53T-200A/B
LP068
Scaffold
Lean Amine
To NHT#2/DHT#1/
GOHT#2/NHT#3
LP126
LP127
LPND
From
53C-202
LV2008
53E-206
Drain and Vent
TV2057
FV2003
To
53C-202
LP123
FV2013
Recycle Amine
From 53G-205
Excess Reflux
From 53G-207A/B
Pumped
Cond
PV2033
Close During
Steam Dwell
PV2039A
Sweet Flash Gas
To 53F-610
PV2039B
To
Flare
Rich Amine From
NHT#2/DHT#1/
GOHT#2
Rich Amine
From NHT#3
ST-300
LP
(Sample)
To
Flare
PSV-2035
PCV2038
Nat
Gas
¾" Steam &QuikTurn
IP#1 (TEE)
XV-3001
From
53T-200A/B
FV2016
LP059
53G-302B
53G-302A
¾" Steam &QuikTurn
IP#2 (TEE)
From
53T-202
53G-402B
53G-402A
53C-204
Three Phase Separator
Flash Drum
20' X 73'
75psig @ 650degF
RUMBLE
Install 2 ½"
Rinse Water
2" Steam
QuikTurn & Quench
IP#276A (TEE)
2" Steam &QuikTurn
IP#276 (TEE)
To
CSWD
Slop Oil
To Plant 52
53G-206
53E-202A
53G-204A
53G-204B
Chemical Cleaning Legend
QuikTurn Injection
(cleaning flowpath)
Block
Quench
Effluent / Drain
Vent
Rinse
Cycle per procedure
Swing Valves
FINAL
REV 1
PROPRIETARY TO RTI EU B.V


2" Steam &QuikTurn
IP#5 (TEE)
SW From 53D-100
WW To 52C-305
To PEW Return/ NRU
Scaffold
Drain and Vent
TV-1022
53E-107
CW
To 53C-201
To 53C-100 (Startup)
HV1004
FV1009
FV1010
LPND
FV-1000
LP277 (To Sample)
FV-1001
To Flare
PSV-1046
53G-102A
53G-102B
53E-100A
53E-100B
53E-100C
53G-111A
53G-111B
53C-101 Stripper 10.5' x 108.5' 75psig @ 650degF FV
50# Steam/ Flare
Install 2 ½" Rinse Water
FV-1004
To C-100
Cooled Cond
53G-104A
53G-104B
Caustic Injection
TV-1013
53E-102
Drain and Vent
2" Steam QuikTurn & Quench IP#165
FV-1007
50# Steam
53E-101
PV-1045B
PV-1045A
SWS Acid Gas From 68C-101
Minimize Flow To SWAG Flare
To SWAG Flare
HV3027
To F-300
HV3028
To F-400
PSV-3054
N2
XV3013
53C-305 SWS Acid Gas 4'x14' 75psig @ 650degF FV
Pumped Cond
(x2)
53G-301A
53G-301B
LP225
Chemical Cleaning Legend
QuikTurn Injection (cleaning flowpath)
Block
Blind
Effluent / Drain
Vent
Rinse
Cycle per procedure
Swing Valves
FINAL REV 1
PROPRIETARY TO RTI EU B.V

How long does this take?

Typical System Cleaning Timeline

TASK	HRS	Day 1
		Days / Nights
Amine & Sour Water Tower Systems		
Confirm isolations and Drains - Rinse for 9pH	4	
Introduce steam & heat up	4	
Inject cleaning solvent into system	2	
Pyrophoric treatment and steam dwell	2	
Switch system to atmosphere	1	
Rinse column	3	
Total - 16 Hours		



Traditional methods typically take 1 – 2 days

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Typical Results

- Project completed in ~16 hours
- 0% LEL, 0 PPM H2S, hydrocarbon free (clean, not just de-gassed), no pyrophorics
- Equipment ready for maintenance with no additional cleaning required (inorganic materials will still be present)
- Effluent volume a function of vessel sizes; typically < 15m³
- Little solids to dispose of if rumble technique applied

The breadth applications

This technology has been successfully applied hundreds of times in North America since 2000 in all types of amine and sour water systems:

- Amine absorbers – LPG, fuel gas, High Pressure H2 recycle
- Amine regenerators – MEA, DEA, MDEA, DGA, DIPA, etc.
- Amine flash drums and sums
- TGTU amine systems
- SRU Acid Gas KO drums

Summary

In summary:

- Use of an organic solvent followed by pyrophoric treatment, both in the vapor-phase, has been proven for close to 20 years in amine, sour water and acid gas service equipment.
- A number of safety, economic and time benefits are associated with this method.
- The process is simple, less mechanical equipment intensive and predictable.
- Completion in less than 24 hours is the norm.