RAPIDSOLVE™

FFS Structural Integrity Screening

For Inspectors & Engineers

Our Vision: Support and develop our client's technical know-how while creating trust

Often times, Inspectors and engineers have to make prompt, accurate and sound decisions with respect to the general Mechanical Integrity and Structural Fitness for continued use of in-service systems (piping, Pressure Vessels, Tanks and peripheral) when indications are found and classified as defect WRT their design standards and operating conditions.

Currently, Plant Reliability engineers, Asset integrity engineers usually have to go through various standards and develop models to compute L1/L2 structural integrity assessments to make Go/No-Go calls during plant runtime and Outage work windows for continued running, repair, replace and required level of follow-up work. Nowadays, plant inspectors are becoming more engaged and required to make such calls too. This is usually time consuming and many times when assessment results are challenged, they are found to be have various inconsistencies and assumptions based on the risk profile of the specialist conducting the assessment.

Another approach has been to involve 3rd party consultants with the expectation of advanced knowledge. It doesn't solve the problem of prompt delivery and comes often times with a high price tag as well as errors in modelling due to limited 1st hand field knowledge of the defect/system and interpreting customer inspection information while offsite.

The level of assessment, quality of the results and final decision directly affects the plants safety, reliability, productivity and thus bottom-line. Industrywide (Chemical and Petrochemical) approximately 30% of defects require in-depth and advanced (Level 3) Fitness for Service evaluations which may involve custom modelling and FEA analysis. The other 70% need less rigor; the component design standard and Level 1 or 2 fitness for service evaluation is appropriate and usually sufficient. The focus of Rapidsolve™ is these 70%.

Rapidsolve™ is developed to give prompt, accurate and consistent L1/L2 defect evaluation and results in minutes. Rapidsolve™ is Modelled primarily around the API579-1 FFS and many years of recognised and generally acceptable good engineering practices REGAGEP. The code validations were done by certified engineers and SMEs using actual plants defect findings, and case scenarios in API579-1 and API579-2. A good understanding of the concept of FFS as specified in API597-1 is required to properly use and interpret the results using this application.

Rapidsolve™ is not intended to replace provincial/state requirements, Design Standard guidelines and user-owner risk profile models. It is not a detailed engineering analysis and not intended to be a comprehensive tool. The tool does not generally take into consideration outside level 1 and Level 2 assessment approaches as well as several complex external loads and conditions. Use of this tool requires adequate knowledge of the steps and limitations as specified in the applicable design standard and FFS-API579-1 standard of the defect analyzed. Engineering analysis plus Level 3 are required when the limitations as detailed in the standard relate to a system in question. The software entails the following features and level of assessment capabilities:

- Structural Integrity & fitness procedure for Defects & Damage Mechanisms.
- Prompt & Accurate Analysis. Visual Aids and graphs for defect illustration.
- Simple Go/No Go Step-wise screening for Repair-Rerate-Replace FFS decisions.
- Cloud based Access. No computer installation required. Free Updates!
- Assessment procedures Verified with known actual and verifiable cases.
- Review & Updates by SME Engineers and Inspectors using an MOC/SR process.

Brittle Fracture Part 3 (L1 & L2)
Assessment Procedure specified uses Method A and B Only of the reference code API579-1/ASME FFS-1. This explores evaluating the resistance to brittle fracture of existing carbon and low alloy steel pressure vessels, piping, and storage tanks. Criteria are provided to evaluate normal operating, start-up, upset, and shut-down conditions. Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

General Metal Loss Part 4 (L1 & L2)
Assessment procedures specified explores cases of general corrosion. Thickness data used for the assessment can be either point thickness readings or Grid detailed thickness profiles. When the Metal loss profile is not general, the method and approach in the assessment procedures of Part 5 are applicable. Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Local Metal Loss Part 5 (L1 & L2)
Assessment procedures specified explores cases of single Thin Ares, closely spaced Local Thin Areas LTSs and groove-like flaws. Thickness data used for the assessment can be either point thickness readings or detailed thickness profiles (Grid). The procedure can be utilized for assessments of stand-alone pits or blisters as per Part 6 and Part 7. When the Metal loss profile is not localized, the method and approach in the assessment procedures of Part 4 are applicable. Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Pitting Corrosion Part 6 (L1 & L2)
Assessment procedures specified explores cases to evaluate systems with widely scattered pitting, localized pitting. The procedure is also applicable for evaluating closely spaced blisters as provided for in Part 7. Procedure assessment condition exceptions: Pitting which occurs within a region of local metal loss, and a region of localized metal loss located within a region of widely scattered pitting are not covered Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Blisters and HIC/SOHIC Damage Part 7 (L1 & L2)
Assessment procedures specified explores cases to evaluate systems with isolated and closely spaced and multiple blisters and HIC/SOHIC Damage. The assessment is applicable for blisters and HIC/SOHIC damage located around weld joints and near structural discontinuities / transitions on the system / component as applicable. Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Weld Misalignment and Shell Distortions. Part 8
Assessment Procedure not specified for this class of defects.

Crack-Like Flaws Part 9 (L1)
Basic assessment procedures specified explores cases to evaluate crack-like flaws. Procedure exceptions: Application for systems with stress intensity factors and reference stress as well as residual stresses is not included. Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

High Temperature Operation and Creep Part 10 (L1 & L2)
Assessment procedures specified explores cases to evaluate systems operating within the creep range as well as the remaining life (Estimated remaining life and number of remaining cycles). Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Fire Damage Part 11
Assessment Procedure not specified for this class of defects.

Dent, Gouge, and Dent Gouge Combinations Part 12 (L1 & L2)
Assessment procedures specified explores cases to evaluate systems with dent, gouge, and dent gouge combinations in components. Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Laminations Part 13 (L1 &L2)
Assessment procedures specified explores cases to evaluate systems with laminations. The assessment is applicable for laminations located around weld joints and near structural discontinuities / transitions on the system / component as applicable. Procedure assessment condition exceptions: Systems under substantial supplementary loads, full vacuum conditions, and application when Impact Test Results Are Not Available. System Geometry: Cylindrical and Conical profile only.

Fatigue Part 14
Assessment Procedure not specified for this class of defects.

Pricing: RAPIDSOLVE™ is offered on various terms to support clients. For subscriptions, please contact tech@rapidsolve.ca

Business Case: Incorporation into Existing Inspection Data Management Systems IDMS.

Existing IDMS Application. Top 10 Market Players

1. Asset Integrity – Oceaneering: ACET®
2. AssetWise Asset Reliability®
3. ASpenTech: Aspen Mtell®
4. General Electric: APM/Predix (Meridium)®
5. Lloyd Register: Capstone RBMI®, All-Asset®
6. Metegrtiy: Vision Enterprise®
7. Aspen Fidelis Reliability®
8. Credosoft: Credo®
9. VERACITY® Pipeline software
10. SAP- Linear Asset Management LAMS
11. Mistras: PCMS®
12. Siemens: UltraPipe®

Similar Products to Rapidsolve®

1. **Codeware:** API 579 / ASME FFS-1 Software. Principle/Concept (API 579/ API 571).
   Major Disadvantage: Standalone application. Requires installation on PC. Part of primary software Codeware.

2. **Becht Engineering:** BechtFFS API 579-1/ASME FFS-1 2016 edition. Principle/Concept (API 579/ API 571)
   Major Disadvantage: Difficult to Model problems. Advanced FFS assessments are not replicable.

3. **Equity engineering:** DamagePlus™ / API 579/ ASME FFS. Principle/Concept (API 579/ API 571)
   Major Disadvantage: Advanced FFS assessments are not replicable. Models are not consistent and results require expert level review due to complex level assumptions imposed on the problem model.

Product differentiation

1. Rapidsolve targets promptness and accuracy of analysis for the majority of screening level FFS needs (>70% of field defects which fail the fabrication requirements in the design standard), while other current market products target rigorous assessment and modeling which eventually require a full fledge advanced level assessment L3 or multi-model /risk reviews. This in turn reduces the efficiency proposal of these applications and thus makes the task more daunting and inefficient. The rational of the designers of Rapidsolve is that every advance level FFS requirement requires a custom based model design and the associated mechanical static + dynamic analysis (Solving the systems boundary problem as a PDE /ODE using Finite element analysis or hand computation) as well as imposing the right level of risk model to ensure all possible field conditions are captured.

2. Current Applications are not designed for all assets owners. Inspectors or plant reliability engineers without asset integrity and advanced engineering background and knowledge find them difficult to use. Rapidsolve is tailored in the models presented to work for the field inspectors who require summary Go-No-go decisions that are correct, as well as the engineer who is heavy on the theory and requires more advanced analysis.

Typical Assessment Process Flowchart Post Defect Observation

<table>
<tr><td colspan="4">Defect discovered on In-service equipment
Check Flaw extent VS design / Material / environmental conditions</td></tr>
<tr><td rowspan="3">Pass

Develop Inspection / risk Mitigation plan/ Frequency.</td><td colspan="3">Fail Rapidsolve®

Evaluate defect using FFS API-579 Screening (L1 & L2 as applicable)</td></tr>
<tr><td>Pass

Keep running, rerate system as required based on passing criteria.</td><td colspan="2">Fail

Decommission / Repair / Advanced FFS Assessment (L3).</td></tr>
<tr><td>Pass

Keep running / rerate as required based on passing criteria.</td><td>Fail

Decommission / Replace / Repair</td></tr>
</table>

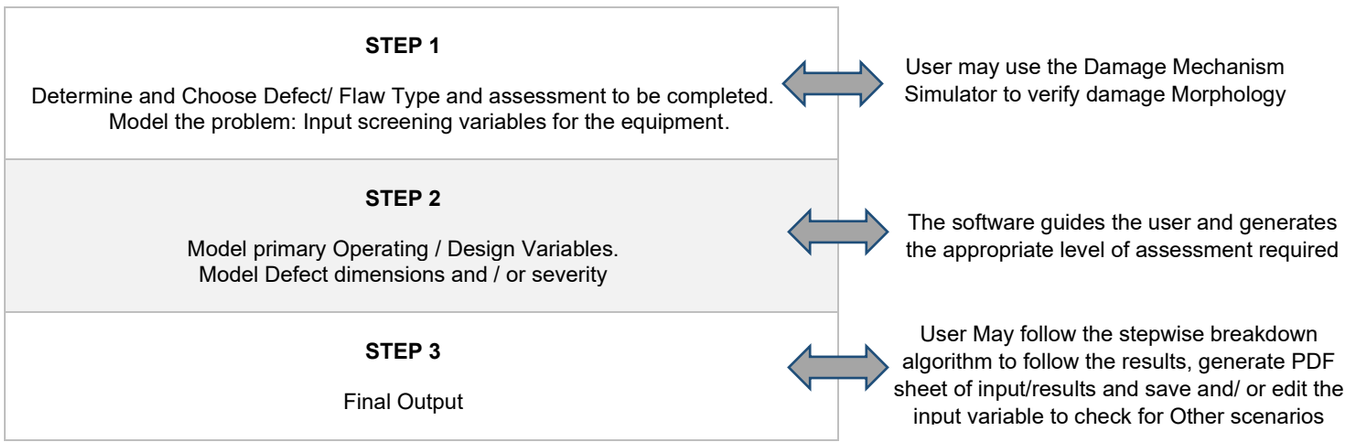
Screening FFS: L1&L2

>70 of assets with defects fall within this Category

Advanced FFS: L3.

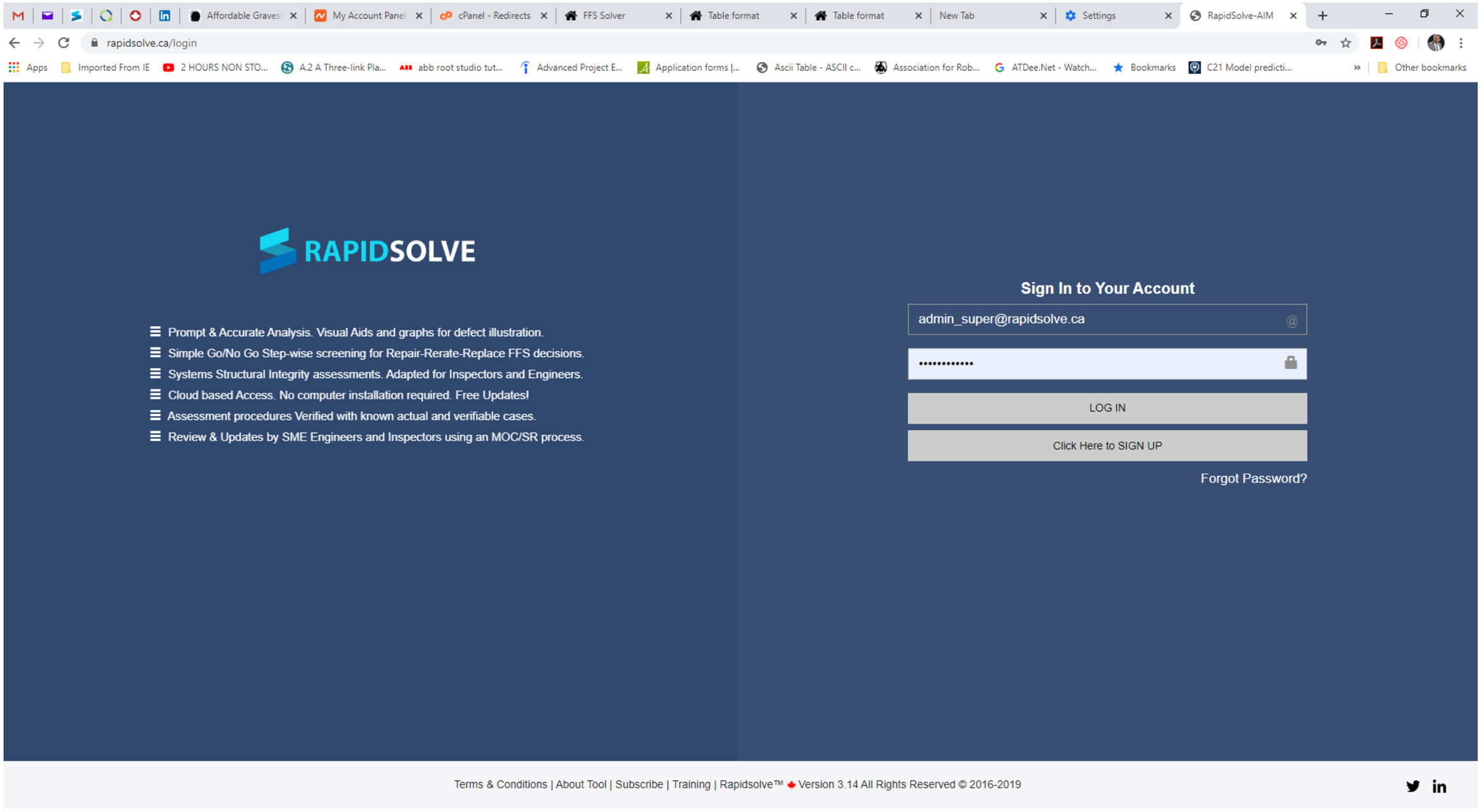
<30% of assets with defects fall within this Category]

ASSESSMENT PROCESS SETUP



Advantages

1. Multiple components assessment and what-if scenarios.
2. Generate raw input variable and results sheet (PDF), Save as PDF, Edit in real-time.
3. Graphical illustrations and stepwise breakdowns of the in-process driving the results. Assessment interpretation is intuitive.
4. Product Enhancement for typical IDMS. Rapidsolve can be packaged as a module within Integrity applications to enhance the use of the product and higher value to the software user.
5. Support and enhance Client Capabilities around understanding and implementing Asset integrity initiatives.
6. Contributor: Process Safety, Asset integrity& Plant Reliability.


Affordable Graves
My Account Panel
cPanel - Redirects
FFS Solver
Table format
Table format
New Tab
Settings
RapidSolve-AIM
rapidsolve.ca/login
Apps
Imported From IE
2 HOURS NON STO...
A.2 A Three-link Pla...
abb root studio tut...
Advanced Project E...
Application forms |...
Ascii Table - ASCII c...
Association for Rob...
ATDee.Net - Watch...
Bookmarks
C21 Model predicti...
Other bookmarks
RAPIDSOLVE
Prompt & Accurate Analysis. Visual Aids and graphs for defect illustration.
Simple Go/No Go Step-wise screening for Repair-Rerate-Replace FFS decisions.
Systems Structural Integrity assessments. Adapted for Inspectors and Engineers.
Cloud based Access. No computer installation required. Free Updates!
Assessment procedures Verified with known actual and verifiable cases.
Review & Updates by SME Engineers and Inspectors using an MOC/SR process.
Sign In to Your Account
admin_super@rapidsolve.ca
LOG IN
Click Here to SIGN UP
Forgot Password?
Terms & Conditions | About Tool | Subscribe | Training | Rapidsolve™ Version 3.14 All Rights Reserved © 2016-2019

DAMAGE MECHANISMS AFFECTING THE PETRO-CHEMICAL INDUSTRY (REFINERY, FERTERLIZER, PROCESSING PLANTS)

RAPIDSOLVE

DAMAGE MECHANISM SIMULATOR

- select an option -

EQUIPMENT - PROCESS DESCRIPTION

Material Type

Carbon Steel Graphitized

Equipment Type

Shell Tube Heat Exchanger: Shell

Years in service

8

Material Thickness

0.8

Internal Pressure

444

Temperature (Max of Process/Skin)

1100

Process: Main Service AND/OR Additive(s)

Ammonia,Hydrogen

System Design

Ext-Coating (Anti-corrosion),PWHT Equipment

Search...

- Buried/soil-Air/cemented Equipment
- Cathodic Protected Equipment
- Ext-Coating (Anti-corrosion)
- Fire/Flame affected Equipment
- Insulated / Fire-Proofed Equipment
- Mismatch Adjoining Metals in Equipment
- Molten cadmium on Equipment
- Molten copper on Equipment

System Stresses & Loads

Applied Induced stress

Submit

EXPECTED DAMAGE MECHANISM(S)

Material Type:Carbon Steel Graphitized

Equipment Type:Shell Tube Heat Exchanger: Shell

Years in service:8

Temperature:1100°F

Thickness:0.8

Pressure:444

Process – Main Service OR Additive(s):ammonia.hydrogen.

System Design:ext-coating-anti-corrosion.PWHT-equipment.

System Stresses & Loads:applied-induced-stress.

Severe Graphitization

Decarburization

Nitriding process

Slight-Moderate Softening

Oxidation

Appearance or Morphology of Damage

- General wall loss; thinning.

Inspection Method

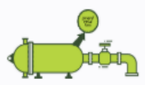
- Real-time Instrument.
- Skin Thermocouple or Infrared Thermographic Scan Monitoring.

Prevention

- Proper Material Design.
- IOW Monitoring.

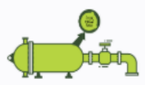
Titanium Hydriding

PART 3
BRITTLE FRACTURE



PART 4
GENERAL METAL LOSS

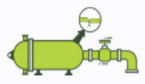
General Metal Loss



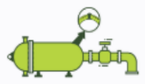
PART 5
LOCAL METAL LOSS

PART 6
PITTING CORROSION

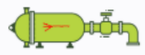
PART 7
BLISTERS & LAMINATIONS



PART 8
WELD MISALIGNMENT & SHELL



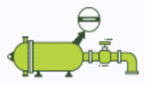
PART 9
CRACK-LIKE FLAWS



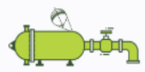
PART 10
CREEP PRONE SYSTEM

PART 11
FIRE DAMAGE

PART 12
DENTS - GOUGES

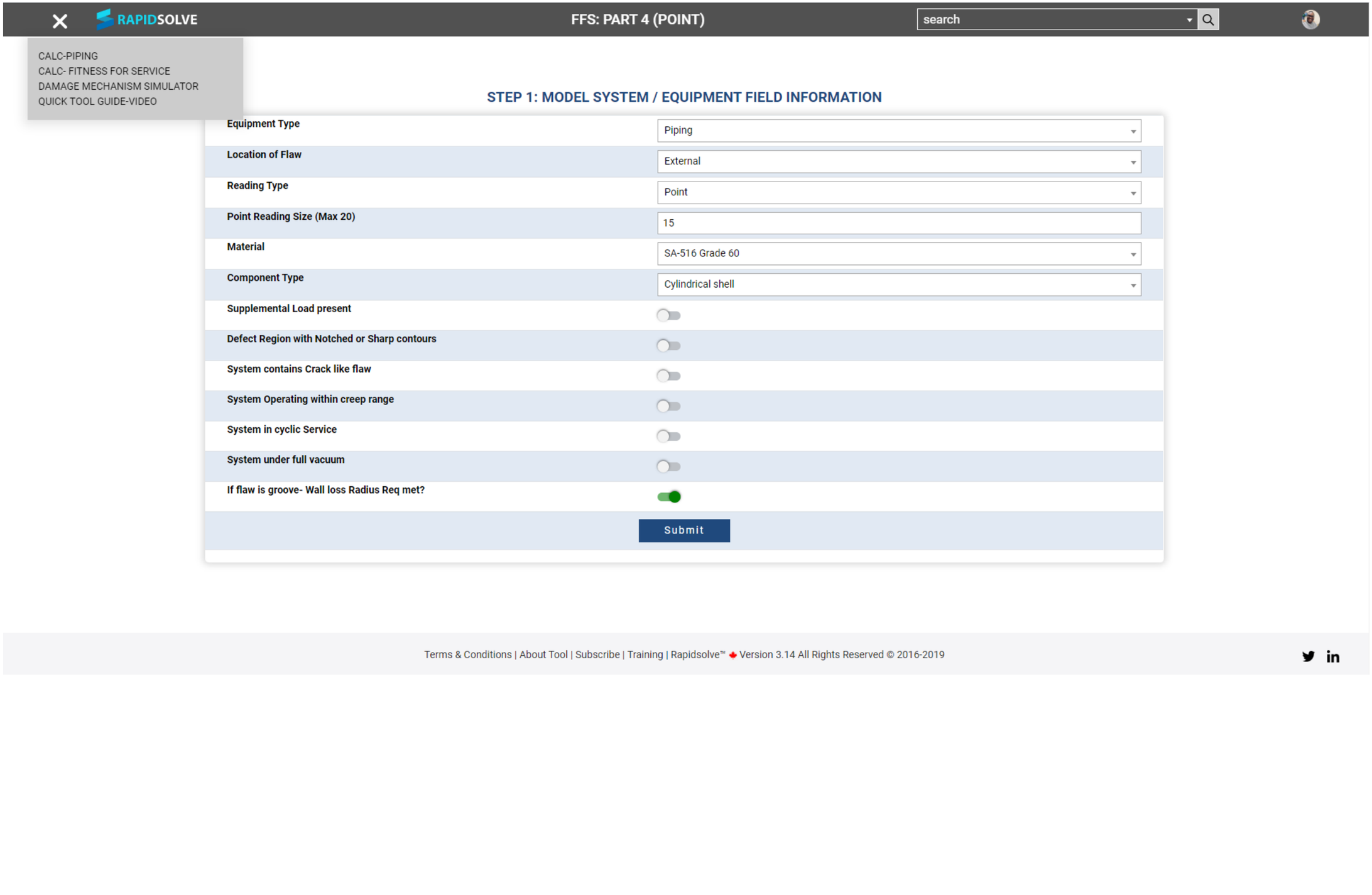


PART 13
LAMINATIONS



PART 14
FATIGUE DAMAGE

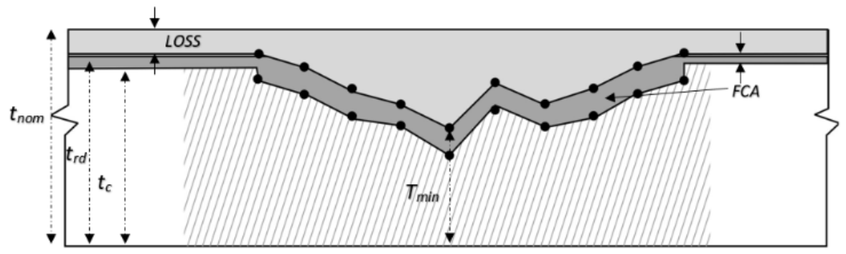
VALIDATION EXAMPLE: FROM API579-2/ASME FFS 2009. PART 4. ASSESSMENT FOR GENERAL METAL LOSS: EXAMPLE PROBLEM 1.



Banjo Ogunlowore
banjo@rapidsolve.ca
LOGOUT

Design Pressure [P]	558
Future Corrosion Allowance [FCA]	0.0787
Nominal / Initial Thickness T	0.629
Design Temp [°F]	716
Material Group	P1
Material Grade	1
MAT Curve	Curve- D
Inside Diameter[ID]	19
Weld Joint Efficiency [E]	1
Allowable Stress [S]	13900
Uniform Metal Loss [LOSS]	-
Remaining Strength Factor [RSFa]	0.9

INPUT DEFECT THICKNESS PROFILE (POINT/GRID)



LOCATION	THICKNESS READINGS
Location 1	0.512
Location 2	0.472
Location 3	0.433
Location 4	0.512
Location 5	0.394
Location 6	0.472
Location 7	0.433
Location 8	0.472
Location 9	0.512
Location 10	0.512
Location 11	0.433
Location 12	0.472
Location 13	0.472
Location 14	0.512
Location 15	0.512

STEP 1 *- Take the point thickness reading data in accordance with paragraph 4.3.3.2. From this data determine the minimum measured thickness T_{mm}, the average measured thickness, T_{am}, and the Coefficient Of Variation (COV).*

Submit

Inputs Equipment | Input Process | Assessment Results

INPUTS -EQUIPMENT FIELD INFORMATION

Equipment Type	Piping
Location of Flaw	External
Reading Type	Point
Point Reading Size	15
Material	SA-526 if Normalized (Curve D)
Component Type	Cylindrical Shell
Supplemental Load present	False
Defect Region with Notched or Sharp contours	False
System contains Crack like flaw	False
System Operating within creep range	False
System in cyclic Service	False
System under full vacuum	False
If flaw is groove- Wall loss Radius Req met?	True

Edit | Save PDF | Print

Inputs Equipment | Input Process | Assessment Results

INPUT PROCESS & SYSTEM DESIGN VARIABLES

Design Pressure [PSI]	558
Future Corrosion Allowance [FCA]	0.0787
Nominal / Initial Thickness T	0.629
Design Temp [°F]	714
Material Group	P1
Material Grade	1
MAT Curve	Curve D
Inside Diameter [ID]	19
Weld Joint Efficiency [E]	1
Allowable Stress [S]	13,900
Uniform Metal Loss [LOSS]	0
Remaining Strength Factor [RSFa]	0.9

Edit | Save PDF | Print

Inputs Equipment | Input Process | Assessment Results

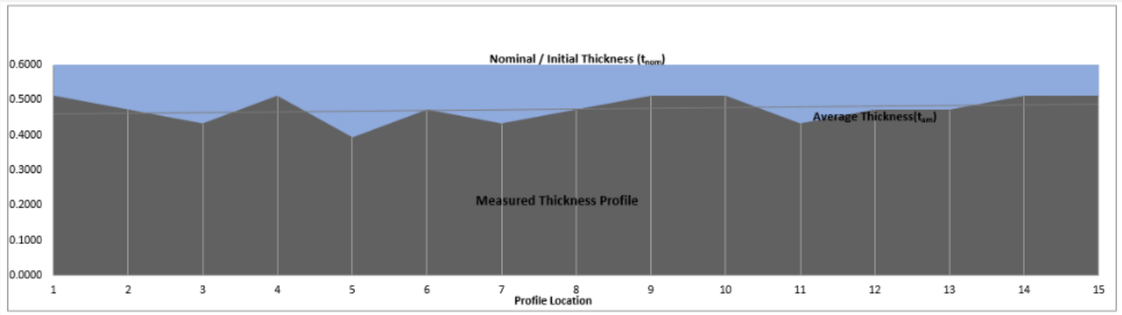
ASSESSMENT RESULTS

LOCATION	THICKNESS READINGS	LOSS	$T_{RD} - T_{AM}$	$[T_{RD} - T_{AM}]^2$	$T_{MIN(C)}$	$T_{MIN(L)}$	T_{MIN}
Location 1	0.5118		0.0367	0.0014			
Location 2	0.4724		-0.0026	0.0000			
Location 3	0.4331		-0.0420	0.0018			
Location 4	0.5118		0.0367	0.0014			
Location 5	0.3937		-0.0814	0.0066			
Location 6	0.4724		-0.0026	0.0000			
Location 7	0.4331		-0.0420	0.0018			
Location 8	0.4724	0.1539	-0.0026	0.0000	0.4003	0.1938	0.4003
Location 9	0.5118		0.0367	0.0014			
Location 10	0.5118		0.0367	0.0014			
Location 11	0.4331		-0.0420	0.0018			
Location 12	0.4724		-0.0026	0.0000			
Location 13	0.4724		-0.0026	0.0000			
Location 14	0.5118		0.0367	0.0014			
Location 15	0.5118		0.0367	0.0014			
Average Thickness T_{am}	**0.451**						

STEP 1 - *Take the point thickness reading data in accordance with paragraph 4.3.3.2. From this data determine the minimum measured thickness T_{mm}, the average measured thickness, T_{am}, and the Coefficient Of Variation (COV).*

STEP 1 - *Take the point thickness reading data in accordance with paragraph 4.3.3.2. From this data determine the minimum measured thickness T_{mm}, the average measured thickness, T_{am}, and the Coefficient Of Variation (COV).*

THICKNESS PROFILE AROUND DEFECT LOCATION



STEP 2 - *If the COV from STEP 1 is less than or equal to 0.1, then proceed to STEP 3 to complete the assessment using the average thickness, T_{am}. If the COV is greater than 0.1 then the use of thickness profiles should be considered for the assessment (see paragraph 4.4.2.2).*

STEP 3 - *The acceptability of the component for continued operation can be established using the Level 1 criteria in Table 4.4, Table 4.5, Table 4.6, and Table 4.7. The averaged measured thickness or MAWP acceptance criterion may be used. In either case, the minimum thickness criterion shall be satisfied. For MAWP acceptance criterion (see Part 2, paragraph 2.4.2.2.e) to determine the acceptability of the equipment for continued operation.*

Circumferential CTP Level 1 Check	The Level 1 assessment criteria are not satisfied. Complete a Level 2 or Level 3 Assessment.
Longitudinal CTP Level 2 Check	The Level 2 assessment criteria for internal pressure are satisfied.

STEP 4 - *The Level 1 Assessment is complete, the component may be returned to service, repaired or altered/rerated based on the outcome above. If any of the STEP criteria fails, Conduct a Level 3 Assessment as applicable.*

Edit | Save PDF | Print