DOCAN©
A CAN DO COMPANY

Fitness for Service & Engineering Criticality Assessments

2022

www.docanco.com Tel. UK: +44 (0)1606 212330 USA: +1 888 874 0964 E: info@docanco.com

ABOUT US

WE ARE AN ADVANCED ENGINEERING CONSULTANCY AND CAE SOFTWARE DISTRIBUTION COMPANY.

WE PRIDE OURSELVES ON OUR CAN-DO APPROACH AND ABILITY TO OFFER CUTTING EDGE SOLUTIONS TO OUR CLIENTS.

We are run by experienced Professional Engineers, Designers and Consultants following an ISO9001:2015 BSI certified Quality Management System.

bsi ISO 9001 Quality Management Systems CERTIFIED

ISO 9001:2015 | Certificate number: **FS 729034**

Our processes and QA system are aligned with providing design and assessment services for high integrity engineering products, and we have a growing track record of delivering on significant safety-critical projects.

OUR BUSINESS IS SPLIT INTO TWO DISCREET DIRECTORATES.

- **Engineering Consultancy**
- **CAE Software Distribution**

Our culture, setup and experience are tailored to working on high integrity systems within highly regulated industries, while having to deliver to challenging timescales and budgets. Our verification processes follow the requirements of our ISO 9001 QMS and are compatible with those companies which operate in highly regulated industries.

OUR VALUES

Our values at DOCAN are the forefront of our identity and vision. They play a major role in the success of every project we undertake.

We are driven as a company, as a team, to bring together our expertise, powerful technologies, industry experience and insights which helps our clients solve their problems.

- To have a can-do attitude
- To have accountability
- To have integrity
- To be honest and straightforward
- To deliver on value and quality
- To have a positive social impact
- To have a customer focus
- To have the most appropriate and innovative technology solutions available
- To be positive
- To have fun and learn on the way

OUR KEY AREAS OF EXPERTISE ARE:

- Engineering Design & Assessment
- Engineering Simulation & Analysis Expertise
- Training Services for Design & Simulation
- Term Contracting Supplier
- Expert and 3rd Party Reviews

We provide a service to solve our clients' engineering problems.

We work in a way which suits our clients. This could be as an independent engineering resource which provides high-level engineering design, analysis and assessment services, through to providing turnkey project solutions. Or we could work alongside your in-house engineers, providing support, technology transfer services and training to meet your requirements.

We are flexible in our approach and work to provide our clients a solution which works.

TYPICAL INDUSTRIES AND EXPERIENCE

Oil and Gas

Automotive

Nuclear

Aerospace

Defence

Electronics & High Tech

Renewable & Green energy

Fitness for Service and Engineering Criticality Assessments(1)

At DOCAN we have a wide range of skills, experience and people.

At DOCAN, we get involved in lots of different applications of engineering pressure systems, covering traditional pressure vessels, piping, tanks, and equipment from R&D, FEED, Detailed Design to Fitness for Service and Decommissioning projects where we serve our clients to guide and verify the defect tolerance or FFS of their systems.

FFSA and ECA can be conducted either for new systems and designs, or for operational systems which have known defects, the latter is becoming more and more prominent as capital equipment gets older and older. Our approach is pragmatic using the most suitable techniques and technology for the problem at hand and can cover local or general corrosion, fire damage, crack like flaws, brittle materials, mechanical damage such as dents and gouges, metallurgical defects, or even potential overload and re-rates which may require a detailed assessment.

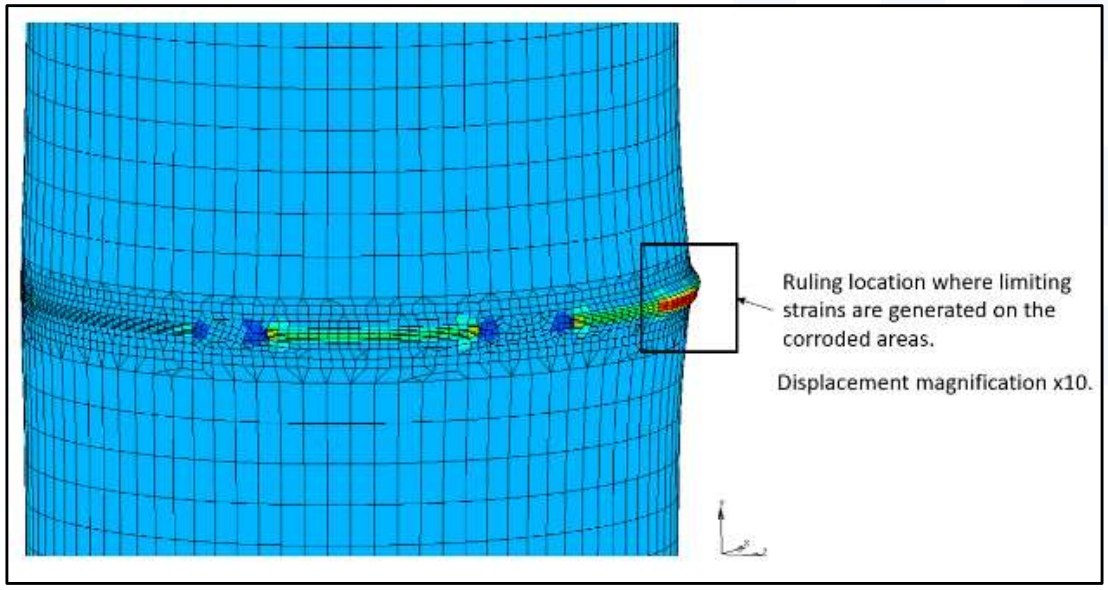
We can perform FFSA/ECA to a variety of codes including API 579, BS 7910, and EDF R6. We employ a range of solutions, including manual calculations and simulation & analysis, and have access to industry leading software such as ABAQUS/ANSYS and Zencrack.

Over time we have undertaken many Fitness for Service and Integrity assessment projects for our clients, from single code checks to complex multi-physics analyses resulting in continuous operation, re-rates, repair designs, decommissioning & lift-out, or shutdowns.

FITNESS FOR SERVICE ASSESSMENT & CONSULTING SERVICES (2)

Some of our FFSA experience includes:

- **Several assessments of pipes and pipelines using manual calculations and simulation-based assessment methods.**
- **Assessments of large pressure vessels and columns subject to significant corrosion under insulation (CUI).**
- **Level 1 & Level 2 API 579 FFSA**
- **Level 3 FFSA using non-linear, fully plastic assessment methods.**



7.3 Longitudinal limiting flaw size criteria

Determining if R_t and t_c satisfy the criteria in API 579 to continue the assessment.

7.3.1
API 579 5.4.2.2 - Step 5:
 	
Is $R_t \geq 0.20$ (Eq 5.7) satisfied for each defect?
 	
If all defects satisfy the criteria then "ALL ACCEPTABLE" will be displayed and the defects can move on to 7.3.2 of the assessment.
 	
If any of the defects are not acceptable, "FAILS PRESENT" will appear and the ID number of the defect will be displayed and it is not acceptable per a Level 1 assessment.
 	
The failed defects will still proceed through the calculation but are not acceptable and require further attention!
	$R_{t\_Check} := Array(1..n, 1..1)$:
	for i **to** n **do**
	  if $0.2 \leq R_t(i)$ **then**
	  $R_{t\_Check}(i) :=$ "Pass"
	  end if
	end do:
	$R_{t\_CheckList} := convert(R_{t\_Check}\ list)$:
	if $ArrayTools:-AllNonZero(R_{t\_Check}) = true$ **then**
	  "ALL ACCEPTABLE"
	else
	  "FAILS PRESENT"
	end if
	"ALL ACCEPTABLE"
	$ListTools:-SearchAll(0, R_{t\_CheckList})$

7.3.2
API 579 5.4.2.2 - Step 5:
 	
Is t_{mm} - $FCA_{mt} \geq 2.5$ mm (Eq 5.8 - for vessels) satisfied for each defect?
 	
If all defects satisfy the criteria then "ALL ACCEPTABLE" will be displayed and the defects can move on to 7.3.3 of the assessment.
 	
If any of the defects are not acceptable, "FAILS PRESENT" will appear and the ID number of the defect will be displayed and it is not acceptable per a Level 1 assessment.
 	
The failed defects will still proceed through the calculation but are not acceptable and require further attention!
	$t_{c\_Check} := Array(1..n, 1..1)$:
	for i **to** n **do**
	  if $2.5\ \text{mm} \leq t_c(i)$ **then**
	  $t_{c\_Check}(i) :=$ "Pass"
	  end if
	end do
	$t_{c\_CheckList} := convert(t_{c\_Check}\ list)$:
	if $ArrayTools:-AllNonZero(t_{c\_Check}) = true$ **then**
	  "ALL ACCEPTABLE"
	else
	end if

7.3.3 API 579 5.4.2.2 - Step 6 is only used if the defect is	
7.3.4 API 579 5.4.2.2 Eq 5.10 This stage determines the L_{msd} distance, if the defect is within this distance of a major structural discontinuity then this calculation is not applicable. These values can be found within the 'CheckingData' file and will have to be verified individually.	L_{msd} **for** i **to** L **end do**

7.6 Reduced MAWPs of failed defects

Calculating $MAWP_s$ & $MAWP_r$ for later use in section 7.7, and determining if values are acceptable.

7.6.1
API 579 5.4.2.2 - Step 8:
 	
Reduced MAWP for failed RSF areas 2.4.2.2.e - Eq 2.2
 	
NOT REQUIRED IF ALL DEFECTS ACCEPTABLE AT PREVIOUS STAGE
 	
The 'if' statement is required because of Maple indexing.
If $n_f > 1$ Maple will treat the RSF_{Fail} data as a list and square brackets must be used as an index.
If $n_f \leq 1$ Maple will treat the RSF_{Fail} data as a value because there is only 1 or 0 values and normal brackets must be used as an index.
The same equation is used in each case.
	$n_f := nops(\lfloor RSF_{Fail} \rfloor)$:
	$MAWP_r := Array(1..n_f, 1..1)$:
	if $1 < n_f$ **then**
	  for i **to** n_f **do**
	  $MAWP_r(i) :=$
	  $\frac{MAWP(RSF_{Fail}(i))\, RSF(RSF_{Fail}(i))}{RSF_a}$
	  end do
	else
	  for i **to** n_f **do**
	  $MAWP_r(i) :=$
	  $\frac{MAWP(RSF_{Fail}(i))\, RSF(RSF_{Fail}(i))}{RSF_a}$
	  end do
	end if
	$MAWP_r$:

7.6.2
Full MAWP list to include MAWPs from 7.4.3 and any reduced MAWPs from 7.6.1 longitudinal assessments if required.
	$MAWP_S := Array(1..n, 1..1)$:
	for i **to** n **do**
	  $MAWP_S(i) := MAWP(i)$
	end do:
	for i **to** n_f **do**
	  $MAWP_S(RSF_{Fail}(i)) := MAWP_r(i)$
	end do:
	$MAWP_S$:

7.6.3
Check to determine if the MAWPs calculated in 7.4.3 or reduced in 7.6.1 are above or below the design pressure.
If any of the MAWP values are below the design pressure, the defects that this occurs will be displayed.
If no defects are displayed, all MAWP values are 'Above or Equal to Design Pressure.
	$MAWP_{S\_Check}$:= $Array(1..n, 1..1)$:
	for i **to** n **do**
	  if $MAWP_S(i) < P$ **then**
	  $MAWP_{S\_Check}(i) :=$ "Below Design Pressure"
	  elif $P \leq MAWP_S(i)$ **then**
	  $MAWP_{S\_Check}(i) :=$
	  "Above or Equal to Design Pressure"
	  end if
	end do
	$ListTools:-SearchAll($"Below Design Pressure", $(convert(MAWP_{S\_Check}\ list)))$

Assessment complete for the longitudinal extent of the defects.	

SOFTWARE

We employ a wide range of tools and software packages across our consultancy business.
We have formed partnerships with world leading software houses which enables us to offer you cutting edge software.
We also have acquired additional tools to support our consultancy work as needed.
Here are some of the tools available to us:

COMPLETE SIMULATION & ANALYSIS TOOLS

- MSC NASTRAN
- ABAQUS
- ANSYS
- ZENCRACK
- EDF RCODE

HPC & CLOUD COMPUTING

- RESCALE
- IN HOUSE HPC'S

Providing HPC resource solutions.

2D DRAFTING & 3D CAD

- SOLIDWORKS
- BRICSCAD
- AND OTHER HIGH-LEVEL PACKAGES

PRESSURE SYSTEMS

- ROHR2
- CAESARII
- PV ELITE & CODE CALC
- TANK

Static and dynamic analysis of pressure systems for piping, vessels and pipeline systems.

1D SYSTEMS ANALYSIS

- FLOWNEX

1 dimensional thermo fluid system modeler and solver with capabilities to handle flows of pure liquids or gases, mixed flows, compressible and incompressible fluids, incondensable, two-phase, and slurry flows.

ENGINEERING MATHEMATICS & AUTOMATION

- MATHCAD
- MATLAB
- FORTRAN, C++, PYTHON

Analyzing, exploring, and solving mathematical problems.

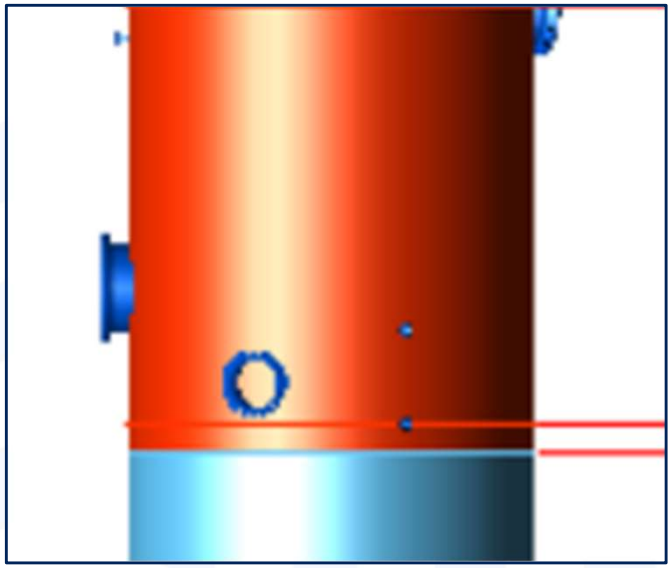
CAN'T SEE WHAT YOU'RE LOOKING FOR...?

CONTACT US TO ENQUIRE ABOUT YOUR SPECIFIC CONSULTANCY REQUIREMENTS **WWW.DOCANCO.COM**

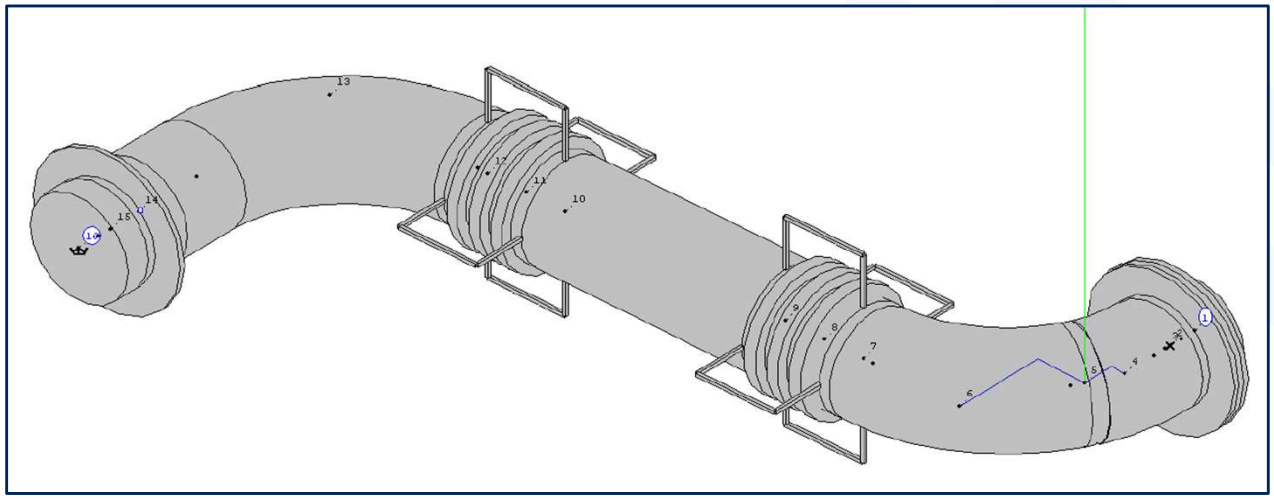
FFSA/ECA PROJECT EXAMPLES

SAMPLE 1

FITNESS FOR SERVICE ASSESSMENT



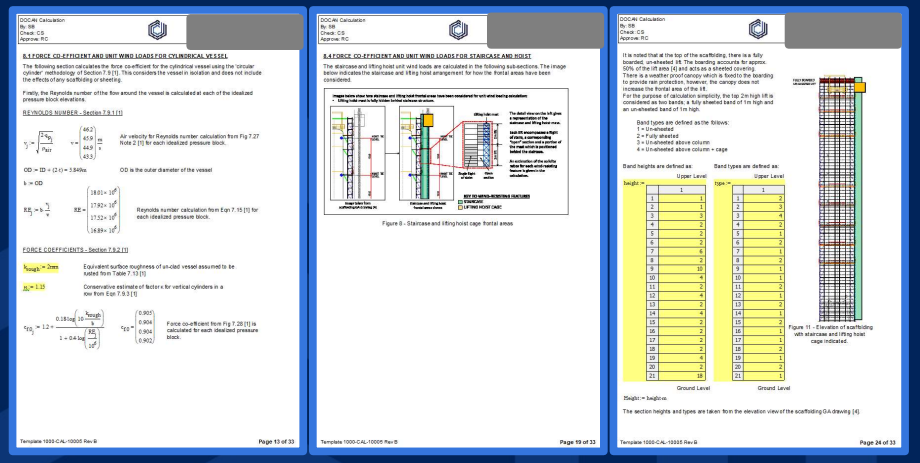
- One of our recent FFSA projects involved assessment of internal corrosion within a vessel adjacent to a piping attachment on a UK site.
- We tackled this problem area by taking a multifaceted approach considering loading from design conditions, wind, and the attached piping including gimbaled joints.
- We utilized multiple packages from our suite of software including ROHR2, PV Elite, and MSCOne.
- We were able to demonstrate that the defect was FFS and guide the client on when remedial action should be implemented.

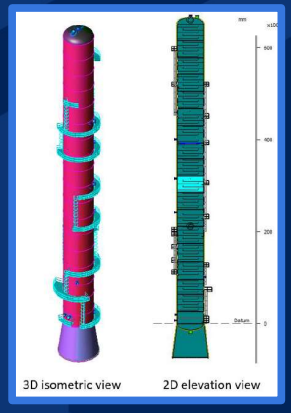


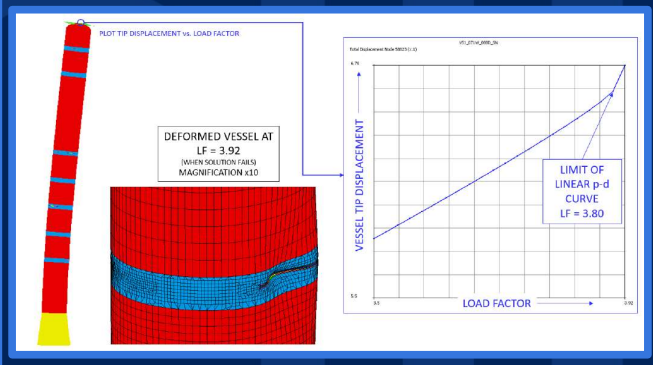
SAMPLE 2

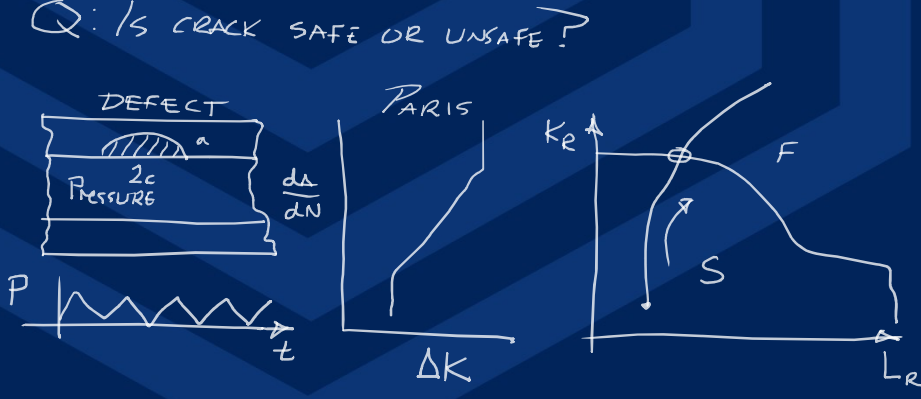
FRACTIONATOR COLUMN

- **Phases of work:**
  - **Part 1 - Initial FFSA**
    - Vessel only, no scaffolding.
    - Supply 3D CAD model of column to client.
    - Defect tolerance for crack like flaws using FAD
  - **Part 2 – FFSA inc. wind loading**
    - Calculation of wind loading on scaffolding and hoist from first principles.
    - PV Elite modelling and FEA based FFSA for operation and shutdown conditions including wind loading and sheeted scaffolding.
    - Determining optimum repair strategy to maintain structural integrity.
  - **Part 3 – Post TAR2021 FFSA**
    - Review completed repairs and update FFSA.
    - Determine any additional repairs to be completed.







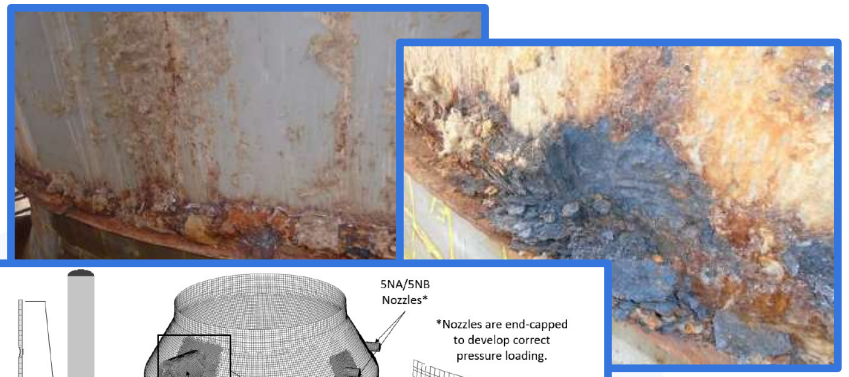


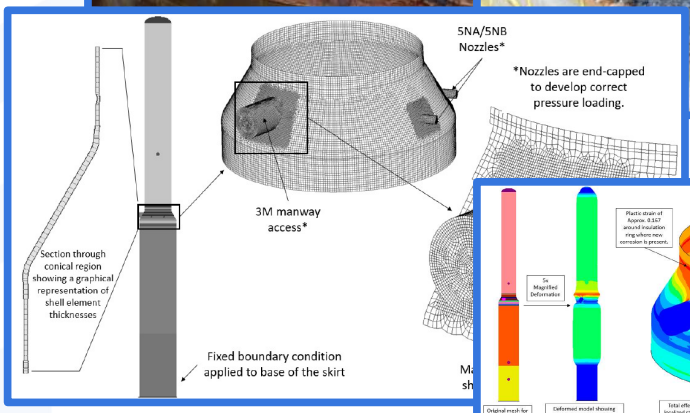
- **Approximately 2 years of assessment, calculation and design work, working with client and various sub-contractors**

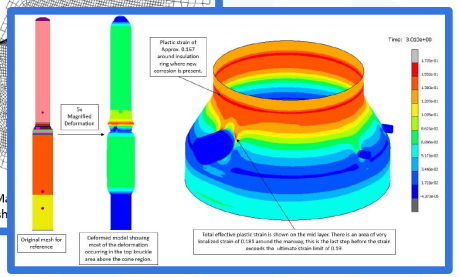
SAMPLE 3

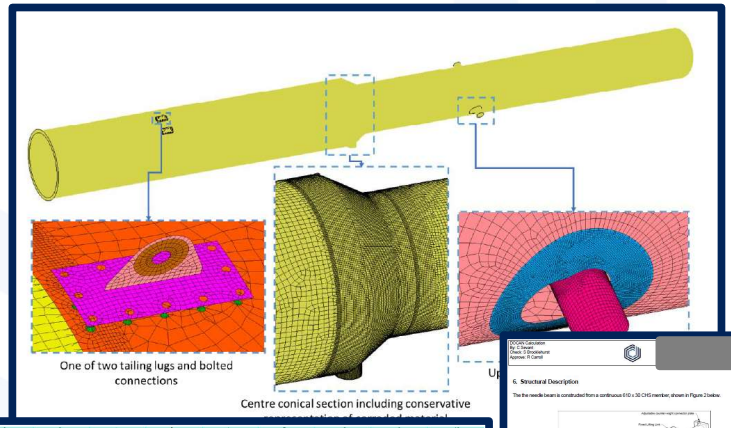
PRESSURE VESSEL FFSA & DECOMISSIONING SUPER LIFT (+400Te)

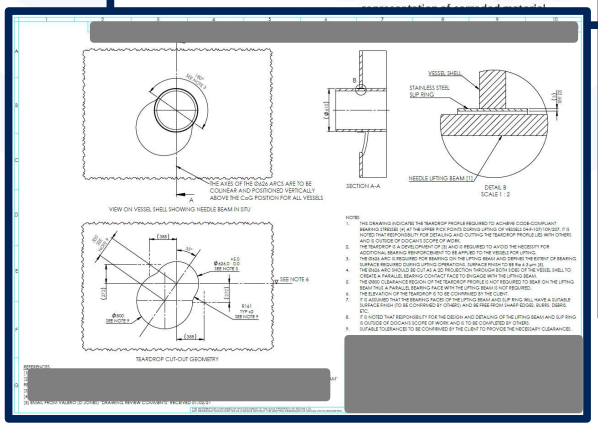
- **Level 3 FFSA performed for pressure vessel to verify the effect of high levels of corrosion around the middle conical section.**
- **Detailed FEA models used to represent the vessel and model the corroded areas.**
- **Tasks undertaken by DOCAN:**
  - 3D CAD modelling of corroded area
  - Manual calculations
  - Detailed FEA modelling
  - Level 3 FFSA
- **Vessel was shown to be FFS up to TAR2021.**
- **Decommissioning lifting of vessel required verification of corroded middle section and around the lifting points.**
- **Tasks undertaken by DOCAN:**
  - Manual calculations and 3D CAD modelling to determine mass and CoG of complete vessel.
  - FEA modelling of complete vessel including attachment points.
  - Re-design of upper lifting point to reduce local stresses.
  - Produce drawings for vessel modification at upper lifting point.

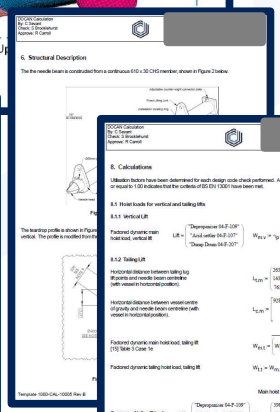


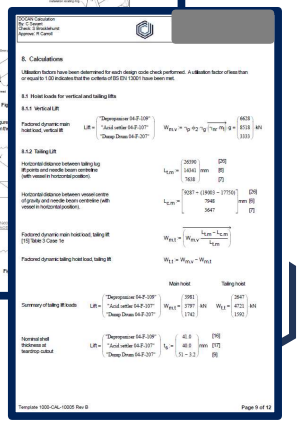












CONTACT US

CALL – **UK** +44 (0)1606 212330 – **USA** +1 888 874 0964
EMAIL - INFO@DOCANCO.COM
WEBSITE -WWW.DOCANCO.COM
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