On Line Repair of DCU Vessel
Skirt Cracks at Reliance SEZ Plant

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Dhirubhai H. Ambani
Founder Chairman Reliance Group

- 1966 - Establishes Textile mill in Naroda, Gujarat, India
- 1977 - Public share offering Raised money from public offerings oversubscribed 7X
- 1982 - Builds fiber/filament plant in Patalganga
- 1995 - Builds Polyolefin plants at Hazira
- 1997 - Builds multi-feed cracker at Hazira
- 1999 - Builds Jamnagar refinery
- 2002 - Acquired IPCL a state run company
- 2008 - Builds JERP refinery at Jamnagar
- 2009 - Begins KG D6 gas production
- 2013 - Builds PBR/SBR plants at Hazira
- 2015 - Builds PTA plant at Dahej
- 2015 - Builds PET plant at Dahej
- 2018 - Many J3 units commissioned
## Performance - FY17 (Consolidated)

<table>
<thead>
<tr>
<th>Category</th>
<th>$ bn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue/turnover</td>
<td>66</td>
</tr>
<tr>
<td>Exports</td>
<td>27</td>
</tr>
<tr>
<td>EBITDA</td>
<td>10</td>
</tr>
<tr>
<td>Cash profit</td>
<td>8.6</td>
</tr>
<tr>
<td>Net profit</td>
<td>5.5</td>
</tr>
</tbody>
</table>

### Business Segments

**Refining and Marketing**

- Revenue: ₹3,06,095 cr
- EBIT: ₹25,869 cr

**Petrochemicals**

- Revenue: ₹1,25,299 cr
- EBIT: ₹21,179 cr

**Oil and Gas (E&P)**

- Revenue: ₹5,204 cr
- EBIT: (₹1,536) cr

**Retail**

- Revenue: ₹69,198 cr
- EBIT: ₹2,064 cr

**Digital Services**

- Revenue: ₹23,916 cr
- EBIT: ₹3,174 cr

**Media and Entertainment**

- Revenue: ₹1,839 cr
- EBIT: (₹25) cr
Reliance Industries - Businesses

**Refining & Marketing (R&M)**
- Operates the world’s largest and most complex refineries with crude processing capacity of 1.24 million barrels per day

**Petrochemicals**
- Integrated petrochemical player - in Top 10 rankings globally
- One of the world’s oldest and largest polyester fiber and yarn producer

**Exploration & Production (E&P)**
- Onshore and offshore exploration and production in India
- Significant presence in US shale business

**Retail**
- Largest retailer in India with over $5 billion turnover
- Caters to over 3.5 million customers every week

**Digital Services (Jio)**
- Providing world’s most affordable data and voice services to 138+ mn users
- Based on a world-class all-IP data strong future proof network with latest 4G LTE technology

**Corporate Social Responsibility (CSR)**
- Top spenders in CSR (Rs. 771 Cr.) within country with main focus on rural transformation, healthcare, education and sports

**Media & Entertainment (M&E)**
- One of India’s leading M&E players, with a strong presence across television content production and distribution, theatrical exhibition of films and media services

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Recognized as the world’s No.1 Mega project by Discovery Channel in 2012, we are the largest operating refinery in the world. 1.5% of world’s transportation fuel is produced from Jamnagar refinery.

RIL is amongst the world's leading producer with 24.9 MMT of petrochemicals production and global scale capacities across polymers, polyester, fibre intermediates and elastomers. RIL holds 36% and 33% domestic share in polyester and polymer markets respectively.

Reliance’s KG-D6 gas discovery has doubled India’s natural gas supplies. The block has the potential to produce 40% of India’s gas production (3.6mn barrels per day).

Listed amongst the top 10 for ‘Best Places to work’ in India by LinkedIn, 2017. Our chairman Mukesh D. Ambani is the only Indian on the Forbes Global game changers list.

World’s largest and fastest growing mobile data network and country’s most cost efficient digital services platform. Jio has progressed India to No.1 position from 150th in terms of data usage (1.2bnGB/month).

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SUCCESSFUL BACKWARD INTEGRATION FOR FEEDSTOCK SECURITY IN PET & POLYESTER PRODUCTION

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Coke Drum Details

Inside Diameter : 8.840m

Drum wall thickness : 43mm (40 + 3mm SS 410 clad)

Cone wall thickness : 52.5mm (49 + 3.5 mm SS 410 clad)

Metallurgy of Skirt : SA-387 Gr.11 CL.2 (Plates)

Metallurgy of Shell/Cone : SA-387 Gr.11 CL.2 + SS 410 clad

Drums operate at 12 hour cycle
Severe cracking was observed on skirt weld joints and knuckle joints of the support skirts at an early age of 3 to 4 years.
• Classic skirt attachment failure locations.
• Blend Geometry of upper knuckle to vessel not smooth.
• Multiple conventional repairs at the SC1 location.
Reliance – AZZ Planned Scope

Phase 1 (Scope Performed During 2 Week Turnaround Window)
• Pre-Turnaround model knuckle transition geometry to generate a desired transition contour.
• Excavate and Repair knuckle joint cracking using an automated welding temperbead process.
• Using an automated overlay and template grinding process modify the transition contour of this area to meet the requirements of the designed geometry.

Phase 2 (Scope Performed with Units On-Line)
• Repair skirt cracks with a high quality weld deposit while the drums are online to minimize production loss.

Repairs Performed on 8 Drums in Parallel
Phase 1 – Knuckle Transition Repair

- Penetrant Inspection shows cracking at the top of the knuckle to vessel transition.
- Cracking ranged between 9mm to 25mm in depth.
- One location 35mm deep required ID/OD repair.
- Cracking was excavated until a clear PT was obtained.
Automated temperbead welding was used to re-weld the excavated areas. This deposit was then contoured to remove the last layer and to blend into existing geometry.
• Additional weld metal was then applied to add material for template grinding operation to obtain improved transition geometry.
Phase 1 – Knuckle Transition Repair

- Surface Contour after template grinding.
- Model of transitions area
• Initial cracking in this area was experienced after 3 years in operation.
• Over time, several manual repairs were performed using conventional welding methods. Failure frequency of these repairs eventually necessitated a longer life solution.
• The extent of damage in this area was less predictable and presented a larger risk to overall schedule.
• A decision was made to develop procedures to allow the repairs to be performed with the vessels on-line during available safety windows.
• Although the existing damage was significantly more extensive than the original plan, this decision was successful.
Phase 2 – Skirt to Knuckle Weld Repair

- Multiple repairs were made to this weld as needed to continue operation.
- Over time, the skirt and the knuckle became increasingly misaligned.
- This misalignment resulted in a decrease in size of the repair welds and created a location for future crack incubation.
Phase 2 – Skirt to Knuckle Weld Repair

- In some cases the mismatch was large enough to allow the skirt to almost touch the cone.
• The initial plan was to remove the damage metal and reinstall a weld that provided acceptable root geometry.
• The severe misalignment required that the width of the root opening be increased significantly to allow a proper geometry after welding.
Phase 2 – Skirt to Knuckle Weld Repair

- Weld build-up was used to reconstruct the excavated weld bevels prior to installation of the root pass.

![Bevel Reconstruction](image1.png)  ![Reconstructed Bevel Ready for Root Pass](image2.png)
Phase 2 – Skirt to Knuckle Weld Repair

- After root reconstruction, automated temperbead welding was used to fill and cap the groove.
- Because these repairs were performed on an operating unit, the repairs had to be timed so that enough weld metal was applied during the work window to prevent cracking during the operating cycle.
Phase 2 – Skirt to Knuckle Weld Repair

• Because 8 drums were being repaired in parallel using a temperbead process, careful tracking and monitoring of the status of each drum was required.
• Since repairs were made in operation, each team had to be ready to start work efficiently at the beginning of their work window.
• Effective communication and cooperation between Reliance and AZZ crews was likely the most important contribution to success.
Phase 2 – Skirt to Knuckle Weld Repair

- PAUT was used to inspect all welding upon completion.
- An average of 6 repairs were identified in each circumference with a maximum of 12 repairs on one of the vessels.
Phase 2 – Skirt to Knuckle Weld Repair

- Final Repair area with dye penetrant developer.
- Typical contour and surface finish for each drum.
• The largest on-line skirt repair was completed with minimal impact to unit production and excellent safety performance.
• Automated temperbead welding was used to perform the majority of welding with excellent PAUT results.
• The knuckle geometry was modified to reduce stress concentration and increase operating life.
• The complexity of working on 8 drums in parallel was managed using update and communication tools.
• Cooperation between Reliance unit personnel and AZZ provided an atmosphere for success.
Thank You!

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