



## Project Summary

### Organization:

Zakum Development Company

### Solution:

Offshore

### Location:

Abu Dhabi, United Arab Emirates

### Project Objective:

- Assess the structural integrity of the wellhead platform in the wake of a ship impact, and specify repairs necessary for reinstatement of oil production.
- Verify that primary members and piles were able to withstand a one-year storm event prior to certifying the platform for continuity of helicopter landing and berthing of large vessels.
- Substantiate the insurance claim resulting from the collision so that the losses incurred would be covered.

### Products used:

SACS

## Fast Facts

- The ship impacted the deck leg with a force of 485 metric tons, causing a 6.6 percent loss in platform strength.
- Optimizing subsea inspections allowed divers, inspectors, and other personnel to work within weather-related time constraints.
- SACS analyses verified the post-repair platform strength against the pre-impact strength, enabling the platform to be recertified for operation.

## ROI

- Subsea inspections by divers were reduced from 134 days to 34 days—a 75 percent savings of inspection time and a USD 850,000 savings in project costs.
- Only the repairs required to reinstate structural integrity were performed, effectively reducing inspection and repair costs from USD 3.75 million to USD 1.15 million.

# ZADCO Uses SACS to Reinststate Ship-impacted Wellhead Platform

Using Bentley Software to Simulate Impact and Assess Damage Saves ZADCO USD 2.6 Million in Restoration Costs

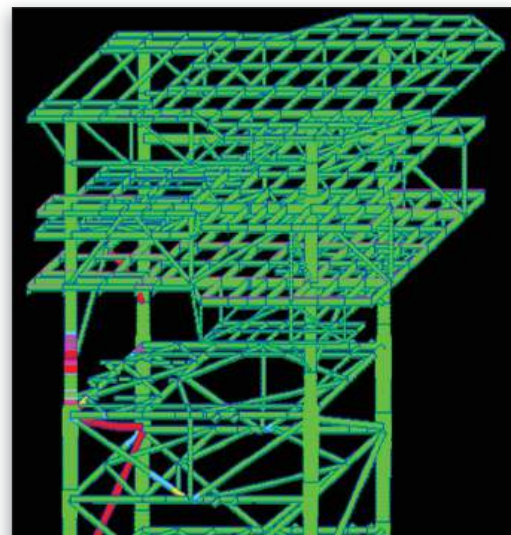
## Mandate to Minimize Losses

Located offshore of Abu Dhabi, United Arab Emirates, Upper Zakum is the fourth largest oil field in the world. Zakum Development Company (ZADCO) is developing the field on behalf of Abu Dhabi National Oil Company (ADNOC) and shareholders in the joint venture between ADNOC, ExxonMobil, and Japan Oil Development Company Ltd. When a 1,600-ton marine vessel hit an operating wellhead platform in the field, ZADCO had to evaluate and reinstate the structural integrity of the platform before oil production could resume.

Each day that production halted represented a loss to the joint venture shareholders. ZADCO successfully reduced project time and costs by using SACS to carry out the ship impact analyses in-house, then outsourced the detailed engineering. Direct savings in inspection and repair costs alone totaled USD 2.6 million, which is 70 percent of the total project cost. In addition, the faster project time resulted in the early release of the platform for operation, and the technical documentation generated from SACS simulations allowed the company to substantiate the insurance claim resulting from the accident, saving the operator considerable costs.

## Structural Integrity Threatened

In the wake of the ship's collision, the unrepaired wellhead platform was determined to be capable of surviving seasonal storms, but was only able to support the landing of helicopters and the docking of light vessels. With production halted until the repairs could be carried out, ZADCO was challenged to assess and repair the platform as quickly as possible so that it could be returned to service and losses could be minimized. This had to be accomplished while mitigating risk, ensuring safe startup, and avoiding environmental pollution. Moreover, the accident and resulting damage had to be substantiated in such a way that the insurance claim would repay the losses incurred.



*Using SACS for its assessment enabled ZADCO to understand the post-impact behavior and determine potential threats to the integrity of the platform.*

Performing a structural analysis of the platform was complicated by several factors. There was no current SACS model available to jumpstart the required analyses, and the vessel speed data required for modeling the impact of the accident was unreliable. In addition, the platform piles were driven into weak-to-hard rock, making it difficult to model the nonlinear soil-pile interaction in combination with a nonlinear inelastic structure.

## Assessing Damage with SACS Modules

ZADCO opted to carry out a rapid, iterative boat-impact analysis in-house using various SACS modules, including SACS Precede for platform modeling and load application; SACS PSI for pile and soil property modeling; and SACS Collapse for non-linear boat impact analysis and parameter coding, and for result verification.

*“SACS software and its tailor-made enhancements are very useful tools for structural integrity engineers to use when a quick and workable solution is required in the shortest possible time.”*

— Wilson John, Structural Integrity Engineer, Zakum Development Company

**Find out about Bentley at: [www.bentley.com](http://www.bentley.com)**

**Contact Bentley**

1-800-BENTLEY (1-800-236-8539)  
Outside the US +1 610-458-5000

**Global Office Listings**

[www.bentley.com/contact](http://www.bentley.com/contact)

The non-linear boat impact analysis performed in the SACS Collapse module helped to accurately simulate the post-impact behavior of the platform and the spread of damages, which included buckled deck and jacket braces, a dented and ruptured deck leg, and platform deformation. Vessel speed at the time of impact was estimated by comparing damage measurements. It was determined that the ship impacted the deck leg with a force of 485 metric tons, causing a 6.6 percent loss in platform strength.

ZADCO performed a linear static in-place analysis, which included soil-pile structure interaction, to assess the damage caused by the impact and verify whether the damaged platform's primary members and piles were safe for a one-year storm event. The team also carried out detailed dent mapping, and subsea and topside inspections.

### Optimizing Subsea Inspections

To estimate the percentage of the platform that suffered degradation due to the impact, progressive collapse analyses were carried out from three critical directions. This involved testing performance of pre-impact, post-impact, and post-repair ultimate strength analyses, and then tabulating the resulting reserve strength ratios.

Conducting impact analyses with SACS allowed ZADCO to optimize the scope of the inspections and focus attention on critical subsea nodes (weld joints) that required a more detailed review. The optimized inspection scope and schedule allowed work to be performed within the narrow window dictated by weather conditions. Subsea inspections by divers were reduced from 134 days to 34 days—a 75 percent savings of inspection time and a USD 850,000 savings in project costs.

The detailed inspection reports, backed by accurate impact analyses, damage assessments, and pushover studies, provided documentation for the required short-term repairs as well as technical substantiation for the insurance claim that would cover the losses resulting from the accident.

### Inspection and Repair Savings

The platform was repaired, and structural integrity was restored, so that the wellhead could be certified for operation and reinstated into production in line with Health & Safety Environment (HSE) requirements. The understanding of post-impact behavior gained from SACS analyses helped to execute the stage-wise release of the platform so that



*SACS simulations allowed the company to substantiate the insurance claim resulting from the accident, saving the operator considerable costs.*

it could become operational earlier than anticipated. Production resumed with the platform reinstated to nearly full pre-impact capacity.

By performing the preliminary analyses in-house, optimizing the scope of inspections, and outsourcing the detailed engineering for short-term and final repair packages, ZADCO significantly reduced the project delivery time and costs. Only the repairs required to reinstate structural integrity were performed, significantly reducing repair costs. These savings, together with the savings realized on inspection costs, were 70 percent of the total cost of the project—which was fully recovered as a result of the insurance claim.

ZADCO also reached its risk, safety, and environmental goals. Having a defensible estimation of post-impact platform capacity helped to effectively mitigate the risk associated with this project. By identifying and mitigating possible threats to platform integrity, the team improved safety and prevented damage to the facility and the marine environment. The platform life and usability were ultimately enhanced as a result of the fully updated SACS model, which can be easily referenced for future operations and maintenance.