

# Advance

Issue 2

## **BMT Services - a promise of through-life value**

BMT Fleet Technology (BMT) has been providing technical assistance to the global oil and gas industry since 1973. Continuous investment into our numerical modeling, metallurgical analyses, materials testing, applied welding research and structural design capacity has increased our capability to provide a range of high value engineering consulting and research services. Today the company provides these services on an international level, working through our numerous offices based in Canada and the UK.

From industry leading research, design and in-service support, to end of life failure investigations, BMT adds value to programs throughout the life cycle of client assets and demonstrates its ability to deliver.

BMT will be sharing and discussing many of its research inspired tools with the pipeline industry at the 2010 International Pipeline Conference. These

tools and knowledge base at our disposal have considered design, construction, in-service support and failure investigations, all of which were completed interactively with client companies, regulators and other research organizations. Each project stemmed from a direct industry

requirement to fit design checks and to conduct material testing, provide cold weather operational guidance, site evacuation planning, weld procedure development, integrity assessment and failure investigations.

Contact: Aaron Dinovitzer,  
[adinovitzer@fleetech.com](mailto:adinovitzer@fleetech.com)



### **Research & Development**

Hybrid Laser Arc Welding  
Page 2



### **In-service Support**

Wrinkle Assessment  
Page 3



### **Failure and Forensic Analysis**

Pipeline Failure Investigations  
Page 4

# Research & Development for the Future

BMT's leading edge research in conjunction with industry partners, research organizations and regulators has resulted in the development of tools and services which are routinely used in design and specifications, in-service support, construction, integrity management and failure and forensic analysis.

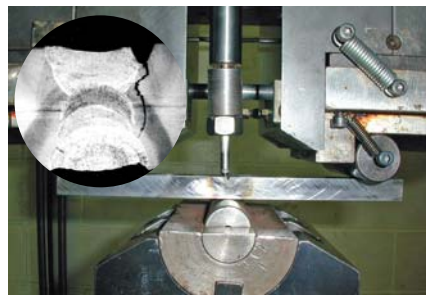


## Hybrid Laser Arc Welding



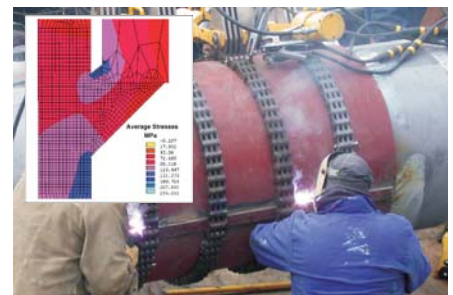
BMT and partners are working to develop, test, and validate a "field ready" HLAW system for full circumferential girth welding of large diameter, high strength steel pipe. Two system designs are being developed (robotic and direct clamp-on platforms) for applications that include both double jointing operations in pipe mills and onshore & offshore pipeline construction projects.

## Hydrogen Cracking



The BMT delayed cracking model considers the effects of groove geometry, weld pass parameters, interpass time & temperature, and ambient temperature on the weld thermal cycle and hydrogen diffusion. The model has been used during pipeline construction to modify girth weld procedures to minimize the risk of cracking and has been applied to thick section welds.

## Sleeving



In-service failures have occurred at pressure retaining sleeves due to defects associated with the sleeve welds. Currently there are no reliable methods to carry out a quantitative fitness for service assessment for a sleeve fillet weld that contains a weld fault. BMT is conducting research to develop flaw acceptance criteria and providing support for engineering assessment.

## Design & Specification

Development of material specifications, cold weather operational guidance, site evacuation planning, and more

### CO<sub>2</sub> Lines

There is increasing interest in the transport of CO<sub>2</sub> by pipeline as part of Carbon Capture and Storage schemes. Options for the re-use of existing pipelines to transmit CO<sub>2</sub> (typically in the gas phase) and for the construction of new pipelines (dense phase) pose particular problems for designers and operators in areas such as fracture control and corrosion. BMT has studied the effects of Joule-Thomson cooling at leaks on the initiation of fracture, and working with BMT Fluid Mechanics, is also investigating the affects of local topography on the dispersion of releases from CO<sub>2</sub> pipelines.

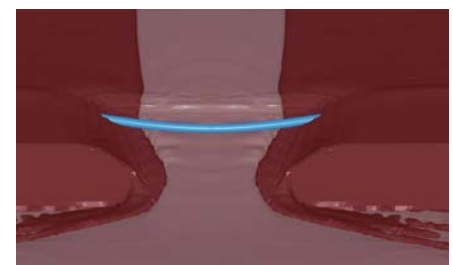
### Ice Scour & Burial Depth

BMT has been active in providing ice structure interaction support for ships, offshore installations and pipelines for more than 30 years. The impact of uncertainties in environmental factors and pipeline design are considered to define the probability of the pipeline response. BMT models consider the large displacement and strain behaviors that occur in an ice scour event.



### Slope Movement

BMT has been developing 3D continuum ALE models to evaluate the effect of slope failures, faulting, landslides or seismic events on pipeline behaviour. The models incorporate the effects of soil type, pipe geometry, layout, and material properties on the pipeline system after the ground movement.

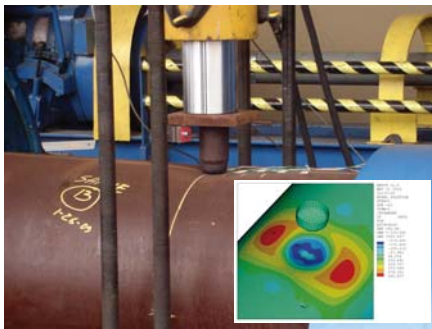


# In-service Support

Our engineering and field staff have developed technical expertise which has proven to be valuable to the pipeline and petrochemical industries. We have applied our expertise in a variety of asset integrity assurance and management programs. BMT can help with integrity management programs, meeting the requirements of pipeline codes and regulatory agencies.

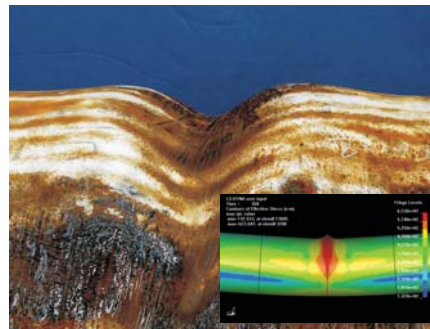


## Dent Assessment



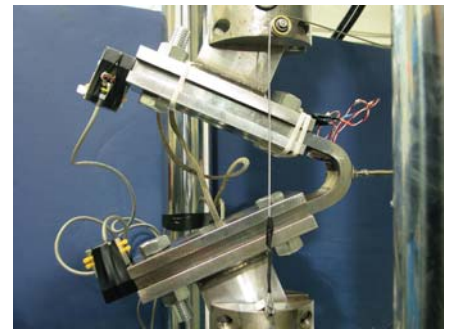
In-line inspection results are used to develop appropriate indenter shapes and sizes to replicate the dent shapes found in the pipeline. BMT's dent assessment model is calibrated through comparison with full scale results and is used to assess the severity of dents and their impact on the fatigue life of the pipeline.

## Wrinkle Assessment



BMT continues its research into developing advanced numerical modelling techniques and provides ongoing support using a validated fatigue life assessment methodology to assess individual field wrinkles, in terms of the safe operating life of the pipeline, identified through in-line inspection tools.

## Damage Assessment



BMT is conducting customized small scale structural fatigue tests and developing advanced material models to determine the effect of geometry, deformation and loadings on the low cycle fatigue behavior, strain limit for crack initiation and wrinkle assessment.

# Construction

BMT provides project support through experienced and certified welding and inspection, structural and materials expertise.

## Trials Design & Support

BMT staff, well versed in fracture and integrity challenges, have supported large scale trials of new pipeline technology throughout the whole life cycle. These trials have ranged from initial feasibility studies, to design and welding engineering during construction. Our engineers have designed defects for trials, ensuring a safe life while still providing a searching test of the material's behaviour. BMT Group's strength is that it is completely independent of material suppliers and contractors, ensuring advice given is objective and credible.

## Procedure Development

BMT is conducting weldability tests on X80 and X100. These tests include WIC restraint testing, resistance to hydrogen susceptibility, resistance to crack initiation and the development of a modified WIC restraint test to evaluate transverse weld metal cracking in X100 welds.



## Materials Tests

Mechanical testing, CTOD, J-R tests, strain aging and standard customized fatigue tests are carried out in BMT test facilities to support construction, fitness for purpose and research, as well as to provide support for in-service, failure and forensic analysis.



# Failure and Forensics

**BMT's multidisciplinary expertise in the areas of structures, materials, inspection, welding and testing helps in understanding the root cause of asset failures and in developing strategies to mitigate the potential for repeat failures.**



## Hydro Test Failures



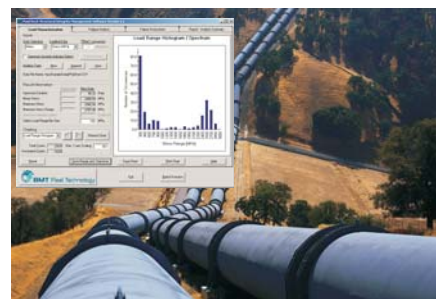
Hydro test failure investigations are undertaken to determine the failure mechanism and to identify contributors to initiation of the failure process, such as material in-homogeneities and structural discontinuities. Investigations are supported by performing engineering critical assessments.

## Failure Investigation



Investigations include evaluation of weld flaws, corrosion, mechanical damage, fabrication quality, material conformance and operational history. Metallography, mechanical tests, soil & chemical analysis are routinely combined in engineering assessments to identify the root cause(s) of the failure.

## Integrity Assessment



Probabilistic fatigue and fracture assessment is the latest addition to BMT's structural integrity management software *FlawCheck*. Using advanced Monte Carlo simulation techniques, *FlawCheck* considers the uncertainty and variability within the input parameters that govern fatigue and fracture mechanics.

## BMT Papers at IPC 2010 & 2012

3D Response of Buried Pipelines Subjected to Large Soil Deformation Effects - Part I: 3D Continuum Modeling Using ALE and SPH Formulations - Part II: Effects of the Soil Restraint On The Response Of Pipe/Soil Systems

Full Scale Cyclic Fatigue Testing of Dented Pipelines and Development of a Validated Dented Pipe Finite Element Model

Evaluating Mechanical Properties of Hybrid Laser Arc Girth Welds

Evaluating A Corrosion Assisted Pipeline Rupture

Design of Pipeline Damage for the BP X100 Operational Trial

EPRG Tier 2 Guidelines for the Assessment of Defects in Transmission Pipeline Girth Welds

A Comparison of Two Major Linepipe Specifications and Possibilities for Harmonization

Construction of the X100 Operational Trial Pipeline at Spadeadam, Cumbria, UK

Simulation of the Response of Buried Pipelines to Slope Movement Using 3D Continuum Modeling

Probabilistic Fitness-For-Service Assessment of Pipeline

Pipeline Mechanical Damage Integrity Management Framework

### BMT Fleet Technology Limited

#### Head Office

311 Legget Drive, Kanata, Ontario, Canada K2K 1Z8

Tel: +1 613-592-2830

Email: [fleet@fleetech.com](mailto:fleet@fleetech.com) Web: [www.fleetech.com](http://www.fleetech.com)

#### Regional Office:

Vancouver, BC, Canada

Tel: +1 604 253 0955