# Report of the Corrib Technical Advisory Group to Minister Dempsey

27 January 2006

## Introduction

The Corrib Technical Advisory Group (TAG) was established by the Minister in August 2005 to manage the Independent Safety Review of the onshore, upstream section of the Corrib gas pipeline between landfall and the terminal site, and to design and implement a new inspection and monitoring regime for the project.

The original terms of reference for the Safety Review were to:

- Identify all relevant documentation relating to the design, construction and operation of the onshore, upstream section of the Corrib gas pipeline and associated facilities.
- Critically examine all such documentation.
- Conclude whether or not, in the professional opinion of the consultant, the proposed installations:
    - have been or will be designed, constructed, installed and operated to appropriate standards, codes of practice, regulations and operating procedures,
    - comply with recognised international best practice,
    - will deliver a facility fit for its purpose.
- Identify any deficiencies in any respect relating to the above.
- Make recommendations regarding such deficiencies.
- Provide detailed guidance on the implementation of any recommendations

Advantica was appointed after an open tender process and commenced work on 1 September 2005. Their scope of work was subsequently extended to incorporate a public consultation component and additional technical analysis, particularly in the areas of societal risk analysis and peat stability. Two days of oral hearings and a period for written submissions to the consultants were built into the review, as was the device of publishing Advantica's draft report and inviting further comments on it.

## Consultants' Final Report Findings and Recommendations

Advantica's final report has now been received. The main findings and recommendations, given in section 7 of the final report, 'Final Remarks and Recommendations ' are reproduced in full below:

### Final Remarks and Recommendations

The independent safety review of the onshore section of the proposed Corrib gas pipeline involved a detailed process of document review, discussions with Shell and their consultants, and consideration of oral and written submissions. A large amount of information was processed (approximately 150 documents in all) and Advantica carried out additional analyses where appropriate as an independent check on specific technical aspects that impact critically on the conclusions and recommendations.

The report presents the detailed findings of the review, which ranges from a general consideration of the process followed in selecting the preferred design option, to detailed analysis of highly technical aspects of the engineering design and risk assessment. The original Advantica review team was expanded to include other Advantica specialists required for the assessment of specific technical documents. To complement Advantica's expertise in soil geotechnics, we obtained information and advice on Irish peat, in particular peat landslip conditions, from the Geological Survey of Ireland (GSI) and also consulted with contacts in National Grid (Advantica's parent company) with direct experience of constructing high pressure pipelines through areas of peat in the UK.

The main findings and recommendations of the review are summarised as follows:

- Proper consideration was given to safety issues in the selection process for the preferred design option and the locations of the landfall, pipeline route and terminal. Quantified risk assessment (QRA) techniques were used to evaluate the levels of risk to the public, and deemed to be acceptable according to recognised and relevant international criteria. However, there appears to be no formal framework in Ireland for decisions on the acceptability of different levels of risk, which should be in place to enable potential developers to gauge whether or not a proposed project is likely to be permitted and to ensure consistency of decisions made on safety issues. *We recommend that consideration should be given by the Irish Government to establishing a risk-based framework for decisions on proposed and existing major hazard pipelines and related infrastructure, to ensure transparency and consistency of the decision-making process.*
- The unusually high design pressure (345 bar) resulted from a cautious approach to the pipeline design, such that the pipeline is designed to withstand the highest pressure it could possibly experience, despite the higher cost of pipeline construction. This approach results in a pipeline with a very thick wall, which offers the main line of defence against threats to its integrity.

- In general, conservative assumptions were used in the detailed engineering design. However, we have identified a number of areas of concern in the documentation reviewed, where detailed technical recommendations should be taken into account in the engineering design, including:
    - Fatigue usage of the pipeline due to variations in pressure to be monitored.
    - Possible vibration effects on small bore pipework at the beach valve to be checked.
    - Monitoring of pipeline stresses due to possible ground movement to be carried out.
    - Additional ground movement analysis to be undertaken to account for the effects of bends, pipe orientation and increased depth of cover.
    - Quality of the pipeline field joint coatings to be checked and inspected during construction.
    - Insulation joint at the landfall to isolate the onshore and offshore cathodic protection systems to be considered or the detailed CP design revised to take account of the possible effects of the offshore section.
    - Internal corrosion rates to be re-evaluated and determination of corrosion rates to be included in a pipeline integrity management plan.
    - Hydrotesting of the pipeline to be carried out to 105% SMYS (Specified Minimum Yield Strength).
    - An initial in-line pipeline inspection run to be undertaken during commissioning.
    - Defect assessment and repair procedures for possible pipeline damage to be established, with appropriate repair materials and equipment to be available at the terminal.
    - Arrangements for surveillance and landowner liaison to be specified.
    - Procedure to be established for monitoring Hydrogen Sulphide ($H_2S$) levels and action to be taken if detected.
- The composition of the Corrib gas is similar to that normally transported through gas transmission pipelines, with a very high methane content. However, because the gas is unprocessed, small quantities of other fluids will be present, that introduce safety issues not normally of concern for onshore gas pipelines, notably internal corrosion, possible blockage of the pipeline due to hydrate formation, and the possibility (albeit very unlikely for the Corrib gas field) of $H_2S$ being produced as the wells age. Pipeline technology for transporting unprocessed gas is well-established, and appropriate measures have been identified to manage these additional hazards.
- Provided that the above recommendations are followed, we believe that the pipeline will be constructed to an appropriate standard and will be “fit for purpose”. However, there is insufficient evidence at present to conclude with confidence that integrity management plans will be

sufficient to ensure that the integrity of the pipeline is maintained to a sufficiently high standard throughout its life. *We recommend that a formal integrity management plan is established prior to construction, including the operational and maintenance philosophy, and that an independent audit and inspection regime for both the construction and operation of the pipeline is established.*

- The quantified risk assessment (QRA) carried out on behalf of Shell has been reviewed in detail and an independent check on the calculated risk levels has been carried out using Advantica's pipeline risk assessment methodology including predictions of the consequences of pipeline failures. The levels of risk to an individual living in the vicinity of the pipeline were found to be within recognised international limits and "broadly acceptable", with the risk levels calculated by Advantica lower than those in the Shell QRA. However, the risk assessment submitted by Shell fails to recognise the uncertainty in the risk modelling for such high design pressures as 345 bar, and takes no account of societal risk to the local population as a whole. An independent assessment of the levels of societal risk, calculated using Advantica's methodology, is included in this report and shows a significant increase in risk with increasing pressure, due to a predicted increase in both the failure frequency and the consequences of a pipeline failure. The calculated societal risk levels are also in a region that would normally be regarded as broadly acceptable, but we note that there is a significant level of uncertainty in the risk calculations at pressures as high as 345 bar.

- Limiting the pressure in the onshore section to pressures no greater than 144 bar (equivalent to a design factor of 0.3, consistent with the design of pipelines passing through more densely populated suburban areas) is believed to be both practical and an effective measure to reduce risk (and will only be required in the early years of the life of the pipeline because the pressure in the gas wells will decline naturally as gas is extracted). In view of the societal concerns, the level of uncertainty in the risk analysis, the extent of extrapolation of onshore pipeline design codes beyond their normal range of application and mindful that the results of risk analysis are only one factor in the decision-making process, we believe that this measure should be taken and the pipeline design revised accordingly. *We recommend that the pressure in the onshore pipeline should be limited to no greater than 144 bar, with a design factor not exceeding 0.3, and the pipeline design revised accordingly.*

- Further work will be required to determine the most appropriate engineering solution to limiting the pressure in the onshore pipeline. The FMECA (Failure Mode, Effect and Criticality Analysis) carried out on the planned subsea systems for Shell could form the basis for the reliability analysis required. *We recommend that a full and technically thorough reliability analysis should be carried out of the subsea pressure control and isolation systems specified in the field design to enable appropriate additional pressure control measures to be implemented and the effective limitation of the pressure in the onshore pipeline demonstrated.*

- The potential for ground movement to damage the pipeline due to instability of the peat, and the possible unsuitability of peat for pipeline construction, were significant issues for the review. The results of

- The pipeline safety review addressed only the design and route of the onshore section of the Corrib upstream pipeline as proposed. It does not include detailed examination of the feasibility of alternative project design options, alternative pipeline designs or routes, and assumes that the gas transported through the pipeline is produced from the existing Corrib wells as identified. *In the event that additional fields were proposed to be tied in to the pipeline at any future date, a full review would be required to consider issues such as extension of the life beyond the initial design life, changes in the fluids in the pipeline or changes in the operating pressures.*

Provided that it can be demonstrated that the pressure in the onshore pipeline will be limited effectively, and that the recommendations made elsewhere in this report are followed, we believe that there will be a substantial safety margin in the pipeline design, and the pipeline design and proposed route should be accepted as meeting or exceeding international standards in terms of the acceptability of risk and international best practice for high pressure pipelines.

[Independent Safety Review of the Onshore Section of the Proposed Corrib Gas Pipeline, pages 57 to 60, Final Remarks and Recommendations, Advantica, January 2006]

TAG's Considered Position and Recommendations

TAG is satisfied that, in contracting with Advantica, it secured the best expert advice available for this task. Furthermore, in the supervision of the contract, TAG was impressed with the rigour and thoroughness of the consultants' work as well as the manner in which they handled the public consultation role that was asked of them. TAG is satisfied that all relevant submissions received from concerned parties received proper attention and, where appropriate, a considered response.

TAG considers that arrangements can be made which will deliver a project that is "fit for purpose" and safe.

TAG accepts all of Advantica's findings and endorses their recommendations.

TAG therefore recommends to the Minister that all the recommendations in the Advantica final report, as listed above, be adopted; those which are directed at Shell should be made binding on the company.

TAG notes that Advantica recommends that societal risk should be evaluated and the results considered as an explicit part of the approvals process. Although societal risk was considered earlier in the project, it did not feature in the final QRA. The scope of Advantica's contract was therefore extended and Advantica itself carried out a societal risk analysis, which is presented in their report. TAG is satisfied with the results of this societal risk analysis.

Having considered all aspects of the relevant part of the Corrib project which have come to its notice, as well as carefully studying Advantica's final report, TAG also makes the following recommendations, over and above those in Advantica's report:

- The primary pipeline design code is hereby designated by TAG to be IS EN 14161; however IS 328 and PD 8010 shall apply where they exceed IS EN 14161. Shell should submit a Code Compliance document to TAG demonstrating how the existing proposals comply with the new designation.

- The beachhead isolation valve, as well as being modified to be capable of remote (as well as local) operation, and to be "fail-safe" (i.e. the valve closes in the absence of a control signal keeping it open), should be designed to incorporate a pressure limitation feature set to prevent pressure exceeding 144 bar in the onshore section of the pipeline. Shell should be required to submit proposals for the design, installation and operation of such facilities. TAG should explicitly approve same before further relevant consents are granted.

- It is recommended that the Minister should now require a Pipeline Integrity Management Plan, covering operational and maintenance issues, to be supplied by the company to TAG. Where relevant, this should demonstrate compliance to the appropriate sections of IS 328.

A date for receiving this should be agreed with the company before further consents are granted.

- TAG specifically recommends that the following measures should be submitted by the company and be approved by TAG before pipeline installation can be permitted to proceed:

  - detailed impact protection design and installation proposals

  - confirmation that the distance between slabs (where utilised) and the top of the pipe should not be less than 500 mm, rather than 300 mm as currently specified

  - where the pipe is laid in peat and slabbing is appropriate, proposals for supporting the slabs from the sub-soil

  - proposals for assessing pipe wall strain at appropriate sections of the pipe

  - proposals for regular inspection of pipe position markers

  - proposals for monitoring of settlement and groundwater levels

  - where piling is utilised, proposals for pipeline fixing to the piles

  - detailed proposals for repair work on the control umbilical system, with a specific limitation on the use of mechanical diggers for such work once the pipeline has been commissioned

- Advantica recommends that additional ground movement analysis is required at bends in the pipeline, for modelling a landslip parallel to the pipeline, and for peat cover of 4m depth. TAG recommends that the company should have this work undertaken and submitted to TAG for approval before pipeline installation. In such consideration, TAG will have regard to compliance with IS 328 / PD 8010 rather than DNV OS-F101.

- TAG recommends that agreed actions to properly preserve the cut sections of pipeline be completed as a matter of urgency.

TAG will design an inspection and monitoring regime for this project, to include supervision of construction. Shell should be asked to indicate their willingness to comply with all reasonable requirements of such a regime (recognising that it does not yet exist).

The Advantica report made recommendations which were not project specific, covering issues such as Ireland's lack of a formal risk assessment framework for assessing large infrastructure projects and how DCMNR should handle future similar projects. TAG intends to comment separately on these matters.

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Future Work

In pursuit of its second task, TAG will now proceed to design and make recommendations for implementation of an appropriate inspection and monitoring regime for the Corrib project.

Once this task is complete, TAG envisages that its work will be finished and that it need not continue in being. Ongoing safety supervision of upstream gas pipelines should be allocated to a permanent body with appropriate legislative authority. TAG will assist with the transition arrangements.

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