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Integrity Assessment of Pressure Equipment
Operations and Design Engineering

CDMS regularly works with operators, EPCMs and various fabricators, providing detailed designs and design verifications of vessels on offshore platforms, floating production storage and offloading (FPSO) vessels and processing plants throughout Western Australia and the North West Shelf. Recent work has primarily involved fitness for service assessments and vessel reratings to support ongoing operations, on both turnaround projects and in-service assessments. The majority of this work has been associated with low temperature, as well as static and cyclic pressure variation assessments.

Temperature drops during blow down conditions can often produce temperatures lower than anticipated during the original process design. When lower temperatures are recorded it increases the risk of brittle fracture if the system has not been designed for these conditions. In some cases the equipment may have been designed to nominal temperature limits but may have more inherent capacity. In others however, it can ultimately lead to vessel failure if the operating conditions are not modified to suit. CDMS has been involved in assessing the integrity of pressure vessels and piping systems for low temperature service on many vessels, rigs and processing facilities for many years.

These vessels may have been in service for some time, and the challenges surrounding typically older systems, is that pressure equipment and material standards change over time. Additionally, some documentation is not always readily available, which presents problems in assessing the materials of manufacture, notch toughness, heat treatment and mechanical properties. Therefore grain structure and toughness properties, on occasion, have to be assumed to be designed to the minimum standard for the carbon steel in question for example, sometimes without heat treatment, which limits its low temperature properties. Even with suitable documentation and the appropriate impact tests, the system may not be suitable for use in temperatures in the range of -40°C to -65°, due to the high pressures of the system and the associated wall thicknesses required at these temperatures. Where the required operating temperature is lower than that permitted by the code, stress analysis can be conducted to determine the safe and effective minimum increase in operating temperature of the vessel, should the general membrane stresses fall below the limits outlined in the appropriate standard.

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For the majority of situations, this additional analysis can demonstrate the acceptability of the system to remain in service. If it is already out of service, producing suitable documentation with a quick turnaround, allows the operator to return the equipment to service within the timeframe of other shutdown work on the site if possible. On occasion, where the required temperatures are too low to demonstrate compliance at full operating pressure, a safe start-up sequence can be determined and the pressure ramped up gradually. In this way, the pressures experienced by the system result in lower stresses being experienced while the temperatures are in the very low ranges, and a return to full operating pressures can be done within a short timeframe. CDMS has often worked together with operators where this type of control is required to establish suitable pressure-temperature related curves are based on their recorded start-up data.

The Australian pressure equipment in-service inspection standard, AS/NZS 3788, permits operating conditions to be allowed to change in vessels. Almost always this requires a rerating of the vessel, but it does not always require an integrity assessment. Even if the vessel is suitable for rerating, some changes can affect the integrity of the vessel and this generally requires a fitness for service assessment, to analyse the impact of the change on the vessel performance over time. Parameters such as temperature increase or decrease, extending past the previous cyclic life or changes to the cyclic data, as well as accumulated corrosion and service conditions can affect the vessel integrity.

If the vessel is in low temperature service and requires rerating, AS/NZS 3788 requires that the vessel complies with the latest versions of the design standards for low temperature requirements, even if it is being rerated to the original fabrication standard. Since these requirements may have changed between standards releases it can sometimes require an increase of the minimum allowable operating temperature when the vessel is rerated.

Rerating work has not been limited to low temperature requirements only, but this may be a requirement for many reasons. Some of the typical examples of modification include an extension of the fatigue operating life after the initially estimated number of operating cycles has been exceeded, as well as rerating of heat exchangers for increased design pressure. High pressure rerating increase required for some designs often dictates the use of actual material properties, as agreed between the parties concerned, to achieve the desired pressure rerating increase. In such cases non-linear analysis is often required to demonstrate design compliance for the highly stressed regions in the vessel.

CDMS has experience working on a range of operations and is familiar with all the major codes and standards associated with integrity management. The safety culture of major operators is aligned with CDMS' own core values. We have a long history of working with clients to achieve the best outcome, through minimising downtime and unnecessary repair or replacement work, without compromising safety.

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