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Serendra Explosion Incident

Final Report – Part Three
Recommendations

Kroll Advisory Solutions℠

An Altegrity Company

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1. EXECUTIVE SUMMARY

1. Correctly designed, installed and maintained LPG vapour delivery systems for residential and commercial properties are commonly used around the world. They are not intrinsically unsafe and are in many ways preferable to local use of portable LPG containers.

2. International standards and best practice involve the use of some safety features not currently present in the Bonifacio Global City and 2 Serendra installations. These include: fixed positioning and hard wiring of all sensors to avoid user intervention; use of fail-safe (fail-closed) sensor-valve systems; use of under-pressure shut-off valves to detect and prevent large escapes in the consumer pipes and hoses; use of bayonet-fit convenience gas outlets for moveable LPG appliances; involvement of a suitably qualified chemist or chemical engineer in the supply chain design and operation; odoriser concentration monitoring in pipelines; prevention of unauthorised person access to equipment.

3. Consideration should be given to developing a regulatory framework based on international standards and best practice, to govern the design and use of LPG vapour distribution networks in the Republic of Philippines.

4. The 2 Serendra condominium documents *'House Rules and Regulations'* and *'Design and Construction Guidelines'* were poorly drafted and ambiguous in content and application. Consideration should be given to a national model framework for such documents, adaptable to developers' and residents' specific circumstances.

5. No reoccupation of a unit should be permitted after renovation without an engineer's inspection and issue of suitable Certificate of Occupancy.

2. RECOMMENDATIONS

2.1 Applicable Codes and Standards

1. In the USA, *NFPA 54 National Fuel Gas Code* applies to the following fuel gases: natural gas, manufactured gas, liquefied petroleum (LP) gas in the vapour phase only, liquefied petroleum gas-air mixtures, and mixtures of these gases, plus gas-air mixtures within the flammable range, with the fuel gas or the flammable component of a mixture being a commercially distributed product. NFPA 58 LPG Code also applies in the case of LPG systems including vaporisers.

2. Similar standards are in use in other jurisdictions including *AS5601 Gas Installations* and *AS/NZS1596 Storage and Handling of LP Gas in Australia*, *BS6829 Installation of low pressure gas pipework, BS5482 Domestic butane- and propane-gas-burning installations. Specification for installations at permanent dwellings and BS EN 15069 series Safety Gas Connection Valves* in UK and Europe.

3. Examples of international standards which specify odorants include: *AS/NZS 1596-2008 The storage and handling of LP Gas; BS 4250:1997 Specification for commercial butane and commercial propane; BS ISO 13734:1998 Natural Gas - Organic Sulfur Compounds Used As Odorants - Requirements And Test Methods* (readily adaptable for use with LPG vapour); *NZS 5263:2003 Gas detection and odorization; NZS 5435:1996 Specification for liquefied petroleum gas (LPG); ISO/TS 16922:2002(en) Natural gas — Guidelines for odorizing gases* (also adaptable for LPG).

2.2 International Best Practices

1. The use of piped LPG vapour for residential and commercial use has been widespread in developed countries for many years. Examples include Canada, New Zealand, Australia and the USA. The World LP Gas Association (WLPGA) is a useful source of information concerning policy and practice across jurisdictions.

2. Piped LPG vapour for domestic use is becoming more common in emerging countries. These include India, Malaysia, China-Hong Kong and some African nations. Useful sources of information include Towngas China Company Ltd. and Builders Association of India. Some other examples appear in Appendix E.

3. In addition to the standards mentioned previously, there may be local safety requirements or codes of practice together with voluntary good practice by installers and suppliers. For example, in the UK and India it is normal practice to install under-pressure shut-off valves, which can be separate devices or incorporated into the regulator. In the event of a large escape, the line pressure falls and a 'slam shut' valve operates mechanically to stop the flow.

4. Where electrically operated valves are used, such as those associated with a gas detector, a fail-shut type conforming to *BS EN 161:2002 Automatic shut-off valves for gas burners and gas appliances* should be specified. This type of valve will also close off the gas supply in the event of a power failure which would stop the detector working.

5. Examples of some suitable safety devices and related equipment appear in Appendix K for illustrative purposes. This should not be interpreted as a recommendation or endorsement of those specific makes and models.

6. The provision of safety equipment is generally the responsibility of the installer or supplier of the service, not the consumer. The installer or supplier should have available the necessary technical expertise to specify the appropriate device(s), and ensure their correct operation and maintenance.

7. The authors do not consider it justified for the Serendra Condominium Corporation effectively to mandate residents to install a gas sensor and shut-off valve at extra charge in order to use the piped LPG vapour supply in their units. This is even more so the case if the equipment required is supplied through the business administration.

8. Safety and security equipment should always be installed in such a way as to minimise the possibility of end-user interference. For example, electrically powered detectors should be hard-wired so that they cannot be unplugged accidentally or deliberately. Sensors should be permanently mounted so that their locations cannot be changed relative to the probable trigger sources.

9. Frequent and regular inspection and maintenance of critical equipment is essential. This includes items within individual residential units such as leak detectors.

10. If adequate firestopping of vertical channels is present, then the practice at 2 Serendra of installing a single leak detector at the ground level of the riser chase becomes inadequate, since escaping vapour will no longer flow down the chase from upper levels. Alternatively, if open ducts are to be permitted for this purpose, then detectors would be required at the bottom of all riser and dropper chases. These should be combined with electric shut-off valves on all risers.

11. There should be methods available to check odorant concentration at various parts of the supply network; examples of such methods appear in Appendix K. A product chemist or similarly qualified person should be involved in the network design and operation.

12. In some jurisdictions it is common for portable and removable appliances, such as domestic gas ranges, to be connected to supply lines by means of convenience plugs and sockets. The sockets are self-sealing on removal of the appliance plug, and insertion of the plug requires a positive action to engage a latching mechanism. This prevents leakage when an appliance is removed or not correctly installed. Again, illustrations of typical systems appear in Appendix K.

2.3 Suggested Amendments to Legislation

1. A national regulatory framework for the design, installation and use of piped LPG vapour and other fuel gas systems is recommended. This could be achieved by adopting existing international standards or combining selected parts of them.

2. In future developments using piped LPG vapour or any other fuel gas, suitable sensors and shut-off valves inside the units should be considered part of the infrastructure. They should be pre-installed in such a way that they can only be moved or changed with the express authority and knowledge of the installer and/or supplier. This provision should form part of the national regulatory framework.

3. Future buildings should be equipped with convenience outlets for fuel gas supplies, and corresponding plugs ready-fitted to hoses made available with appliances.

4. Consideration should be given to a model framework for condominium occupancy rules which can be adapted for specific circumstances. The purpose of this would be to avoid the ambiguities and contradictions seen in the 2 Serendra documents.

5. *Building Code of the Philippines Section 309 Certificate of Occupancy* should apply to renovations of condominium units and similar individual dwellings within Group B buildings. Re-occupation of the unit should not be permitted simply on the basis of the original Certificate of Occupancy applying to the entire building.

6. *Building Code of the Philippines Section 309 Certificate of Occupancy* should apply to renovations of condominium units and similar individual dwellings within Group B buildings. Re-occupation of the unit should not be permitted simply on the basis of the original Certificate of Occupancy applying to the entire building.

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