International Society for Tracer and Radiation Applications

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Assessment of industrial pipeline integrity in Underground Pipelines of Gas District Cooling (GDC) System Using Radiotracer Technology

In September 2020, Gas District Cooling (GDC) System Putrajaya Sdn Bhd (Plant 3) has contacted Malaysian Nuclear Agency (Nuclear Malaysia) under the Ministry of Science, Technology & Innovation (MOSTI) to conduct pipeline integrity assessment to its 6km length and 3-4 meters depth buried pipeline. For past 2 years the plant has experienced continuous water loss which was approximately 4 m^3/day. In order to ensure the efficiency of the cooling system, they have to top up the loss regularly. Previously, the plant has sought Direct Current Voltage Gradient (DCVG) technique to solve the issue but to no avail. The management of GDC wanted the diagnostic of the plant to be carried out immediately. Therefore, Plant Assessment Technology (PAT) team from Industrial Technology Division has adopted Radiotracer Technology to locate and verify the leakage location from its pipeline and solve the issues.

Radiotracer technology (RT) is the introduction of radioactive material inside the domain and the tracing of radiation emitted by this material is conducted externally using scintillation detector. Any drop of velocity or flow rate from upstream to downstream fluid flow is susceptible to potential leak area. Leak detection using radiotracer techniques is one of the most widespread applications of radiotracers in industry. RT is very sensitive, effective and competitive for on-line leak detection. It is used for on-line leak detection and can achieve the detection limits up to 0.1% of stream flow.

In principle, District Cooling concept begins by chilling water at a centralized plant. Chilled water is then pumped through a long underground piping system to heat exchangers in different buildings. The heat exchangers are used to transfer the chilling energy from the water (Primary Loop) to customers' internal building chilled water loop (Secondary Loop). Cold air is dissipated within the building via a typical Fan Coil unit and Air Handling Unit. Warm water returns to the heat exchangers for a continuous closed loop cooling process again.

It is understandable, the best practice in conducting leak detection in buried pipeline is to provide the dug pits along the pipelines prior radiotracer injection to install the sensors. Nevertheless, Plant was unable to provide us with dug pits. Thus, the placement of sensors was made only inside the available Valve Chambers (VC). In this work, our team has mounted scintillation Sodium Iodide (NaI) detectors on the pipe lines, accessible through Valve Chamber (VC) pits as shown in Figure 1. Thus, the sensors are in very good contact with the pipe that leads to accurate data acquisition. Therefore, for this works, only a few sensors were used for leaks determination. Prior to that, the AGT team (Authorized Gas Tester & Entry Supervisor for Confined Space) from GDC has assisted us in mounting and securing the NaI sensors at its location respectively. We adopted Velocity Drop Method, in which a reduction/drop of velocity is an indication of the leakage. Therefore, the sodium iodide scintillation detectors (NaI) were arranged according to the assigned location and the radioactive data were recorded by data acquisition system (DAS) respectively. The injection of radioactive tracer was carried out after all sensors were secured accordingly and the Multichannel Analyzer (MCA) and Single Channel (SC) have gathered the background data.

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Figure 1. Google Map of the plant and respective NaI detectors location

Figure 2. AGT works by GDC Plant 3 Team

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By identifying the main locations of NaI detectors' assignments, we measured the distance of NaI in accordance to their designations as shown in Table 1. In this paper only results at Harriot Watt are given.

Table 1: Detector locations and their distance to one another

Location	Designation	Distance (m)
Herriot Watt	D1-D2	83
Field	D5-D6	99
Pullman-Marina	D7-D8	57
MOTAC	D9-D10	130

Figure 3 shows the example of radiotracer results of fluid flows at Herriot Watt University compound. S1 and S2 are the Supply flow whereas R1 & R2 are the return flow from the building respectively. The peak height is different from one to another due to the contact of NaI with the pipe. Most probably, the thickness of insulation/ diameter is NOT constant along the pipelines although from the common pipes. From the height of the peaks, it can be deduced that the insulation of pipe/diameter is thicker and similar at S1 and R2 whereas thinner at S2 and R1 respectively. Therefore, the individual peaks are showing different height but similar sharpness.

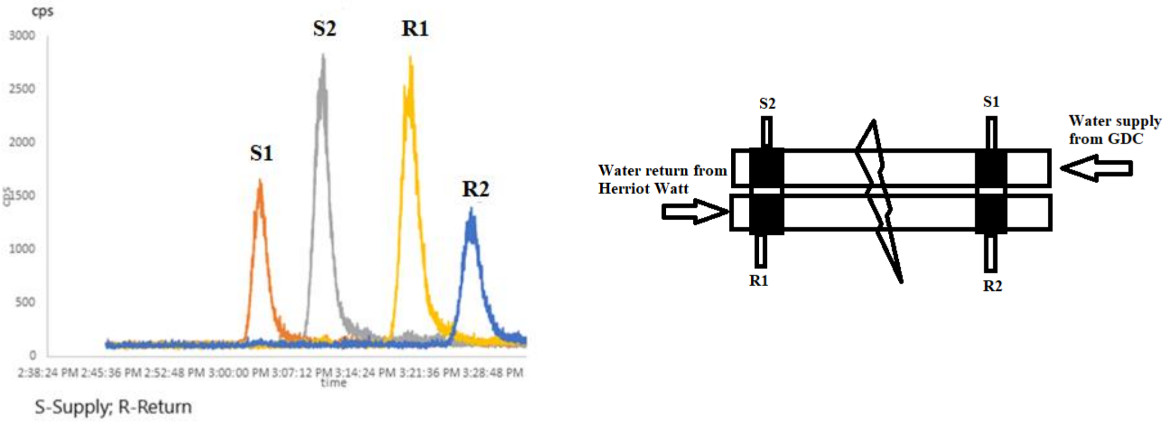

Figure 3: Overall results of Tracer Technique at Harriot Watt University

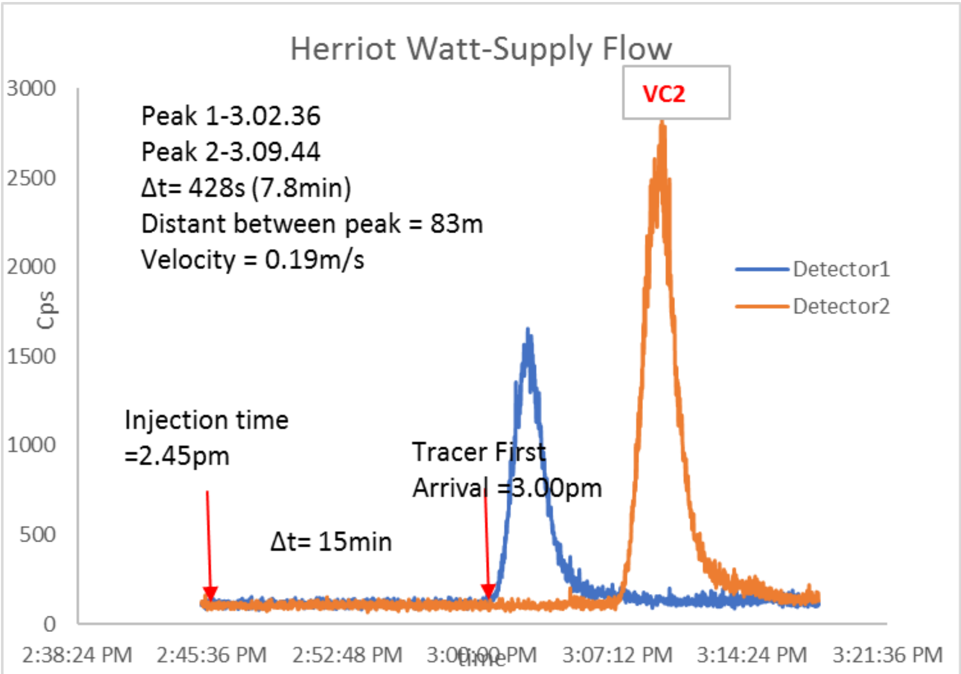

Figure 4: Supply flow at Harriot Watt University using MCA 1

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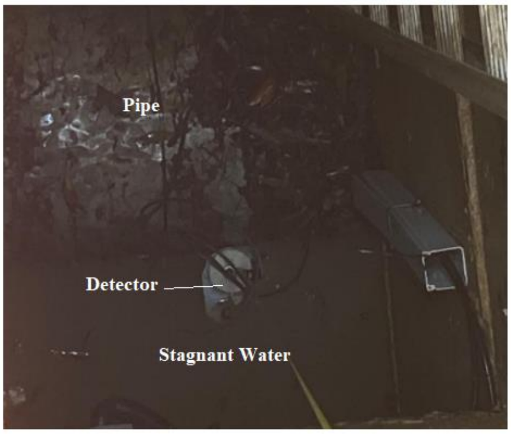
Moreover, Figure 4 shows that the tracer breakthrough or Tracer First Arrival was recorded after 15 minutes upon ^{99m}Tc injection. The different of peak was calculated as 7.8 mins with distant of 83 m between peak. Thus, the calculated velocity of the fluid flow is the ratio of distance to time which equals to 11.4 m/min. In order to verify whether there was any presence of leak between the supply and return flow, we calculated the velocity of water at return flow. The calculation was similar as supply flow. Thus, the calculated water velocity at return flow was 12.4 m/min. Hence, the velocity at Supply and Return flow was comparable that showed no indication of leakage at Herriot Watt pipelines.

Besides, the Plant Owner requested us to measure the stagnant water inside the Valve Chamber (VC6) where the Marina pipeline was located. They suspected the presence of leakage whereby the water from the pipeline was seeping out stealthily to the stagnant water nearby. Thus, after completion of data acquisition at respective locations, a single detector was lowered and direct contact measurement was conducted at the stagnant zone inside the VC6 as shown in Figure 5. An earlier assumption was made that, any increment from background value was considered as elevated radiation reading and translated as leakage.



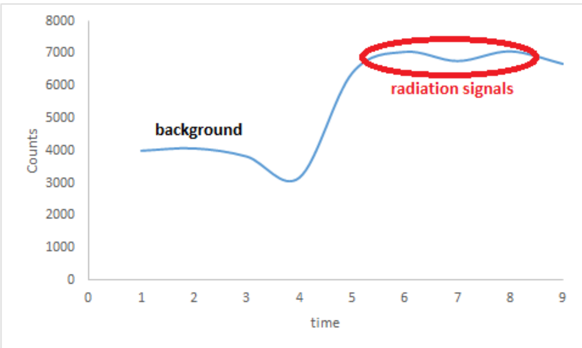


Figure 5: Radiation signal at Marina-Leak verification

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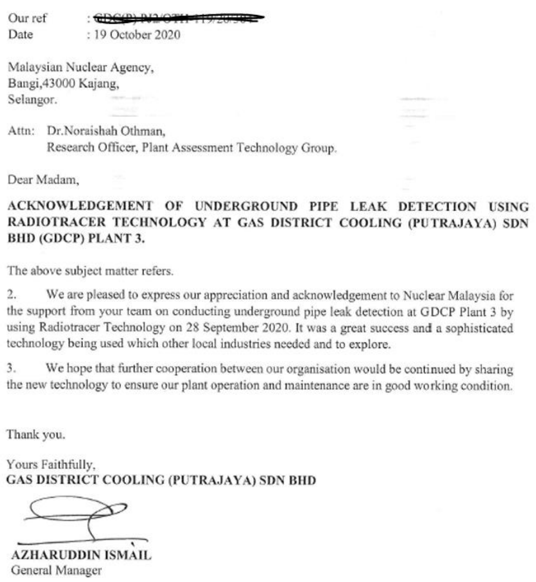
Upon completion of the radiotracer works, the Plant has contacted us that they managed to salvage about 70% of the losses. Since the arrangement of sensors were made on the small number of available VCs, about 30% of leak was still not identified. We suggested Plant to provide us with dug pits to solve the remaining problems. In conclusion, Nuclear Malaysia has successfully conducted pipeline integrity assessment of the respective pipeline and verified the leakage location of Plant 3. The highlight has been put up by PETRONAS internal circulation a day after the radiotracer works as shown in Figure 6. Appreciation Letter was sent to us upon the successful works and we are glad to serve the stakeholders and public.



Our ref : [redacted]
Date : 19 October 2020

Malaysian Nuclear Agency,
Bangi,43000 Kajang,
Selangor.

Attn: Dr.Noraishah Othman,
Research Officer, Plant Assessment Technology Group.

Dear Madam,

ACKNOWLEDGEMENT OF UNDERGROUND PIPE LEAK DETECTION USING RADIOTRACER TECHNOLOGY AT GAS DISTRICT COOLING (PUTRAJAYA) SDN BHD (GDCP) PLANT 3.

The above subject matter refers.

2. We are pleased to express our appreciation and acknowledgement to Nuclear Malaysia for the support from your team on conducting underground pipe leak detection at GDCP Plant 3 by using Radiotracer Technology on 28 September 2020. It was a great success and a sophisticated technology being used which other local industries needed and to explore.

3. We hope that further cooperation between our organisation would be continued by sharing the new technology to ensure our plant operation and maintenance are in good working condition.

Thank you.

Yours Faithfully,
GAS DISTRICT COOLING (PUTRAJAYA) SDN BHD

AZHARUDDIN ISMAIL
General Manager

Figure 6. Acknowledgement of Radiotracer Technology by Industry

text and photos:
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