NDT Centre of Excellence
for the nuclear industry

With funding from the IAEA (International Atomic Energy Association) and in partnership with NECSA (South African Nuclear Energy Corporation), the SAIW is leading a technical cooperation project to establish an NDT centre of excellence for the nuclear industry at NECSA's Pelindaba nuclear research facility. *African Fusion* talks to the SAIW's Mark Digby and Harold Jansen about the initiative.

With a special focus on ultrasonic phased array testing (PAUT) and time of flight diffraction testing (TOFD) – both of which are seen as advanced NDT techniques, ideally suited to the critical needs of the nuclear power industry – NECSA and the SAIW, with funding from the IAEA, are partnering to establish a centre of excellence for NDT to advance South Africa's national capability.

"The lack of PAUT (phased array UT) and TOFD (Time-of-flight diffraction) capabilities in South Africa, particularly those focusing on the specific needs of the nuclear sector, has resulted in traditional NDT capabilities being adopted in the nuclear sector, which limit detection success," begins Harold Jansen, the Certification and Qualifications manager for the SAIW.

Also, though, he points out that the number of South African women involved in NDT has been low, with only 13.5% representation since 1980. "Statistics taken from the start of 2021 to 2024 show a drastic improvement in these number with 27% of all new NDT students now being female. As a core outcome of this project, the IAEA has asked us to focus specifically on increasing the numbers of women at the highest levels of the NDT profession, so the initial programme is seeking at least 10 and up to 16 women to train up to 'Level 2+' on these advanced NDT techniques. That means they need to have completed Level 1 and Level 2 NDT qualifications before starting PAUT and TOFD courses at LEVEL 2 – and, for nuclear, beyond Level 2," Jansen explains.

Phased array and time of flight diffraction

Explaining why PAUT and TOFD have been selected for special attention within the NECSA Centre of Excellence for NDT, Mark Digby, the SAIW's Training Manager says these are both advanced NDT techniques that overcome many of the shortcomings of traditional ultrasonic testing (UT).

With traditional UT, he explains, an ultrasonic signal generator and receiver box with an oscilloscope-type display is used to send and receive ultrasound signals via a probe. "There are probes with different angles – 45°, 60°, 70° and 90° probes, amongst others – for seeing different areas around a weld. The testing process is very much operator dependent. The right probe angle needs to be selected for each inspection area, and the operator needs to manually interpret the return signal and write down what he sees on the scope," Digby explains.

Phased array UT uses a probe with 64 or 128 separate transducer elements to enable every probe angle to be covered at the same time, which enables the whole weld profile to be tested at the same time.

Phased array UT, he says, uses a probe with 64 or 128 separate transducer elements, which can each send signals and receive signals. "The combination of all these elements into a single probe that is only 2.0 to 3.0 cm long enables every probe angle to be covered at the same time, so the whole weld profile can be tested without having to change probes. And every angle is included, which removes the risk of missing a flaw because the NDT technician did not have a probe with exactly the right target direction," he says.

Also, though, the encoded data is processed by the PAUT instrument so the operator can see the area being scanned and any flaws that might be present. And there is a vast amount more data to ensure nothing is missed, data that can be saved and relooked at in more detail at a later stage, several years later when the same test needs to be done again, for example," Digby tells *African Fusion*.

A view of NECSA's Pelindaba nuclear research facility in South Africa, where the SAIW is leading a technical cooperation project to establish an NDT centre of excellence for the nuclear industry. Photo by NJR ZA: Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2871304

The Koeberg Nuclear Power Plant near Melkbosstrand in the Western Cape-of South-Africa. According to the IAEA, a third of the countries of the world currently considering nuclear power are in Africa. Egypt, Ghana, Kenya, Morocco, Niger, Nigeria and Sudan have already engaged with the IAEA to assess their readiness, while Algeria, Tunisia, Uganda and Zambia are also looking.

Highlighting the key role of TOFD within the nuclear industry, he says there has long been a demand for a flaw sizing tool that can be used to record and track whether or not an acceptably-sized flaw has seen any significant change. "Time of flight testing gives us this opportunity. The process is very good at sizing in all directions. Let's say there is a small but acceptable inclusion in a weld, we will then need to know when this inclusion starts propagating a significant crack. We therefore regularly need to check the exact sizes of the original defect to ensure it is not going to become dangerous.

"So, TOFD is ideal for use as an in-service NDT technique to monitor the exact size of known defects. While most methods can give us an accurate measure of the length of a flaw, TOFD can highlight the exact length, width and height of that flaw. And, like PAUT, it also produces digital data that can be saved and recalled for comparative purposes at every follow up inspection," notes Digby.

NDT personnel in South Africa, he continues, have been doing in-service NDT at Koeberg and on NECSA's Safari reactor for many years, Koeberg has probably been tested maybe 10 times in the last so many years. So staff there are aware of exactly what the welds were like at installation and how they have changed between each inspection interval. But this is often down to a specific operator using a specific UT machine, a specific probe, and a specific cable. When an operator leaves, though, he or she can leave a very big knowledge hole.

"TOFD can help, because it is much easier to collect the data and that data is automatically stored and referenced for later retrieval and comparison," Digby says.

Sounding a warning note, he mentions that better NDT techniques, such as phased array UT and TOFD, can be unpopular because they find flaws that would not previously be seen. "Some people argue that finding too much is a problem. But it is not as if these flaws were not there before, it is just that we were not able to find them. It is better to know exactly where all the flaws are, and also to size them properly so we can reliably determine exactly how critical each of them is," Mark Digby advises.

Next steps

Turning attention back to the NDT Centre of Excellence for the nuclear industry, Harold Jansen says the intention is to send out invitations to the Top 10 NDT service providers in South Africa to find the highest qualified black and female NDT professionals to make up the first cohort of trainees. "The course will not be free, but it will be heavily subsidised – the SAIW will only be recovering its basic costs – so for a course at this level, it will be a great opportunity for the professional women and for the companies in which they work," adds Jansen.

The equipment needed for the training course has already been ordered, also via local NDT service providers. "We at SAIW appreciate the fact that local procurement of equipment is best practice, both to support the local industry and because it comes with after sales service; the equipment is known to the NDT industry; and providers can also offer training capabilities. South Africa needs a local platform for nuclear-focused research and development, so it is essential to enhance the quality of education, training and competence of NDT personnel and companies, and to feed that competence back into existing training programmes," he says.

Global specialists in PAUT and TOFD have been approached to deliver the training programme, and current expectations are that the first three sessions will take place between September and November this year.

"Since 2000, the SAIW has been involved in Level 1, Level 2 and Level 3 NDT training, qualification and certification for more than 160 AFRA fellows from 17 different countries. This portfolio of evidence is testimony that the proposed project with this strategic partnership will ultimately benefit and support the current Nuclear Industry and the envisaged new Nuclear Build Expansion Programme. "This is imperative for the development of the safe performance and reliable operations of nuclear and other equipment, structures and plants within South African industry," Jansen concludes.

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