Date of Submission

January 2017

Network Innovation Allowance Project Close Down Report

Notes on Completion: Please refer to the relevant **NIA Governance Document** to assist in the completion of this form. Please use the default font (Calibri font size 10) in any electronic submission. Please ensure all content is contained within the boundaries of the text areas.

Network Licensees must publish the required Project Progress information on the Smarter Networks Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

Project Progress

Project Title		**Project Reference**
Ester Fluid Transformer Re-Design		**NIA_SSEPD_0022**
Funding Licensee(s)	**Project Start Date**	**Project Duration**
Scottish Hydro Electric Power Distribution (SHEPD), Southern Electric Power Distribution (SEPD)	Dec 2015	4 Years 9 Months (13 months after the change request)

Nominated Project Contact(s)

David MacLeman

Scope

During this project Scottish and Southern Electricity Networks (SSEN) propose to carry out the development of a 33/11kV power transformer using IEC 60076-14 limits to allow for using an ester-based fluid as an insulating medium at higher running temperatures.

Completion of this project should provide us with a solution which can be used in situations where there are high safety and environmental concerns whilst providing a unit which can be reduced in size and cost.

The project will include the following stages;

- Business representatives liaising with the manufacturer to investigate a range of potential designs
- SSEN will undertake a process of assessing and selecting the most suitable designs for a Continuous Maximum Rated (CMR) unit and a Continuous Emergency Rated (CER) unit based on potential operational and financial requirements
- The selected supplier will then be tasked with the manufacture of selected designs
- A complete unit will then be subject to enhanced transformer type testing processes before being deemed suitable
- Once testing is complete we will re-assess the potential impact on the business and re-visit initial cost benefit analysis
- Online dissolved gas analysis and fibre optic monitoring of winding temperatures will be installed for a period of 3 years
- The new design, if suitable, will be proposed to relevant departments for use in business as usual

Objective(s)

Phase 1 Objectives
- The project will determine if the re-design of transformers to higher temperature limits and use of ester-based fluids can reduce the manufacturing and installation costs of transformers
- The project will determine if the new design limits are compliant with current Eco-design standards

Phase 2 Objectives
- The project will prove the new design in a live environment
- If successful the new design will be rolled out as business as usual

Success Criteria

Phase 1 will seek to investigate the cost and operational implications of re-design and use of transformers built to IEC 60076-14 limits for use of ester-based fluids as an insulating medium.

Phase 2 will seek to investigate any detrimental affects on transformer performance over a 3 year monitoring period.

The success of the project will be to understand the implications of transformer re-design to allow for running at higher temperature limits.

Performance Compared to the Original Project Aims, Objectives and Success Criteria

High level summary:

The project had been progressing with the defined scope as declared within the NIA registration document. The project management methodology utilised included regular project reviews which included monitoring of the progress and updates in costs and business case. **In September 2016 and following a detailed project review, SSEN decided to halt the project and as a result submitted a change request to Ofgem on 28/09/2016.**

An updated cost benefit analysis has shown changes in comparison to the original. There is a reduced base cost (due to updates in internal company frameworks) and an increased method cost (due to the cost of additional material required). **As a result, the latest cost benefit analysis has shown that this innovative technology will not offer the forecast financial benefits**. SSEN investigated the cost of stopping the project at this early stage and decided that the most appropriate course of action is to halt it and refocus its resources on other innovation projects with higher potential for delivering benefits.

The purpose of this report is summarise the work completed to date and provide the key lessons learnt as part of the project.

Problem:

Use of mineral insulating oil, as used in existing transformers, has potential disadvantages in terms of environmental compatibility, fire safety and sustainability. The solution to this issue has traditionally been the use of ester-based fluids such as Midel 7131. Although these products are seen to provide environmental and safety benefits they are also significantly more expensive than traditional mineral oil thus negating large scale use.

Power transformers are designed to IEC 60076-2 which limits winding temperatures to 140°C to stay safely below the ignition temperature of mineral oil. These design parameters are currently used for both mineral oil and ester-based fluid filled transformers.

As mentioned within the method section of the registration document, the project seeks to investigate the potential of designing power transformers for use at distribution level to IEC 60076-14 limits which will allow higher operational temperatures for fluids with higher ignition points.

Performance against scope:

The NIA registered scope was being followed and the implemented project management approach ensured consistent and rigorous delivery. As discussed earlier, after a detailed project review, SSEN has decided to halt the project and not pursue the entire scope, but instead refocus its efforts on other innovation projects with higher potential of delivering benefits to the network operators and the customers.

- **Task 1: Business representatives liaising with the manufacturer to investigate a range of potential designs.**
  Business representatives engaged in discussions with a SSEN framework transformer manufacturer (Winder Power Ltd.) in investigating a range of potential transformer designs that would satisfy the scope of the project. The transformer manufacturer then undertook a review of costs and properties of ester based fluids as opposed to mineral oil and provided recommendations on high level design to SSEN, who made the decision on which design to pursue further.

- **Task 2: Selection of most suitable design**
  After a complete review of ester based fluids and recommendations by Winder Power Ltd., SSEN selected Envirotemp FR3 fluid as the insulating medium for manufacturing the project units. The decision was made on the basis that the Envirotemp FR3 was the least expensive ester based fluid. One key difference between the current practice of using Midel 7131 at appropriate locations (where safety and environmental concerns exist) and the selection of the FR3 fluid for the NIA project is the fact that the former is a synthetic ester fluid while the latter is natural ester. It is known that the natural ester fluid will be subject to oxidation issues while the synthetic fluid will not. However, due to the price differential between synthetic esters and natural esters, and taking account of the cost of separating the fluid from the atmosphere, it has been concluded that the use of the FR3 fluid will be more economical than any other fluid.

- **Task 3: Manufacture of Units by Winder Power**
  Upon the decision to progress with the Envirotemp FR3 fluid, Winder Power progressed to the detailed design of the innovative unit which would then lead to the manufacturing of it. The properties of the Envirotemp FR3 fluid required avoiding contact with the atmosphere because it is a natural ester and can oxidise rapidly in the presence of oxygen. This causes sludging in the fluid and increased viscosity compared to new fluid. As a result the innovative unit required additional features such as the membrane in the conservator, which impacted the cost of manufacturing the unit. As ester fluids have higher viscosity than mineral oil, particularly at low temperatures, the implications of switching operations within FR3 meant that a more expensive tapchanger (with vacuum switching) had to be selected than would be used with mineral oil. At the same time, SSEN signed an updated framework agreement with Winder Power Ltd., which showed a reduced cost of the conventional transformer units. At this point, the project's cost benefit analysis was updated and demonstrated that the innovative transformer will not provide the financial benefits that were initially forecasted. As a result and after investigations by SSEN on the cost of halting the project, it has been decided to halt the project.

Performance against the project plan:

The project was on target for being completed on time. However, due to the updated cost benefit analysis and the decision to stop early, the project is closing prematurely.

Performance against the project budget):

The initial NIA allowed budget of the project was £616,000. At the change request submitted to Ofgem on 28/09/2016, the updated budget was £115,000 to account for the premature closure of the project. The actual cost incurred within the project was **£103,238.08.** The project has therefore been delivered within budget.

Performance against the project objective:

Phase 1 Objectives:

- The project will determine if the re-design of transformers to higher temperature limits and use of ester-based fluids can reduce the manufacturing and installation costs of transformers

The project demonstrated that the use of Envirotemp FR3 fluid as an alternative to mineral oil insulating medium for transformers will increase the manufacturing costs. The justification for the increase of the manufacturing cost is related to the properties of the Envirotemp FR3 fluid which requires equipment that adequately isolates it from getting in contact with the atmosphere. The requirement of a vacuum-type on-load tapchanger due to the viscosity of the fluid also contributed to the increase in cost. Further to the primary reasons as declared above, the Envirotemp FR3 needs appropriate equipment and protocol in order to commence operation in cold weather. Such a fact adds further costs to the solution or restricts its applicability (depending on the mitigation option selected).

The installation costs are not foreseen to vary substantially in comparison to the standard mineral oil unit, but the increase in manufacturing cost was significant enough for SSEN to deem it necessary to halt the project prematurely. In regards to the installation cost, SSEN has assumed that the Envirotemp FR3 unit will not require an oil containment to be installed (as is the case for the Midel 7131 units which present similar environmental benefits as the selected FR3 fluid) and this saving has also been factored in the cost benefit analysis.

- The project will determine if the new design limits are compliant with current Eco-design standards

The Eco-design standards were taken into consideration by Winder Power Ltd. in the detailed design of the innovative unit and are one of the reasons for not being able to reduce the manufacturing costs. It was originally assumed that the ester based transformers would be using less active materials (copper and core steel). However, in the detailed design it was revealed that this wouldn't be possible as the innovative unit needs to satisfy the Eco-design standards. Although the project did not progress to the manufacturing and testing of the innovative unit, the proposed design was compliant with the Eco-design regulations.

Phase 2 Objectives:
- The project will prove the new design in a live environment
- If successful the new design will be rolled out as business as usual

Considering that the project has been halted (due to the very low likelihood of delivering financial benefits and SSEN's direction to engage in value adding activities) and will not progress to the manufacturing and installation of the innovative units, the objectives of phase two cannot be satisfied.

Performance against the success criteria:

Phase 1 will seek to investigate the cost and operational implications of re-design and use of transformers built to IEC 60076-14 limits for use of ester-based fluids as an insulating medium.

The project was able to clearly comprehend the cost implications for selecting Envirotemp FR3 as the insulating medium for a transformer and this is reflected in the updated cost benefit analysis and the decision to halt the project. Further to the cost implications, the project was able to forecast operational implications of the innovative unit which are discussed in the following sections. Therefore, the success criterion of Phase 1 is accomplished and the project is considered a success.

Phase 2 will seek to investigate any detrimental affects on transformer performance over a 3 year monitoring period.

Considering the decision of SSEN to halt the project ahead of manufacturing and installing the innovative transformer, the planned phase two of the project will not take place. Although this success criterion will not be satisfied, the reasons for halting the project demonstrate the value of the continuous review of the projects by SSEN in order to ensure that value for money is achieved from the innovation activities.
The success of the project will be to understand the implications of transformer re-design to allow for running at higher temperature limits.

The design of the transformers for the NIA project was carried out in accordance with IEC60076-14, which allows the ester-filled transformer to operate at higher temperatures than mineral oil-filled transformers. This could not be done by reducing active material significantly, as the design had to meet EcoDesign with respect to the losses, so the higher temperatures could only be achieved by reducing the internal and external cooling surfaces. Appreciating the premature closure of the project, the innovative transformer will not be manufactured or installed in order to understand in practice the limitations and benefits of allowing the transformer to run at higher temperature limits.

Required Modifications to the Planned Approach During the Course of the Project

A change request was submitted to Ofgem on 28/09/2016 requesting the premature closure of the project.

An updated cost benefit analysis in September 2016 has shown changes in comparison to the original. **As a result, the latest cost benefit analysis has shown that this innovative technology will not offer the forecast financial benefits** and SSEN decided that the most appropriate course of action is to halt the project.

Lessons Learnt for Future Projects

Recommendations on how the learning from the project could be explored further:

Although the project has been halted, it has generated some significant lessons in regards to the components of the innovative transformer and how it compares with the conventional mineral oil unit. Furthermore, the work undertaken has revealed why the innovative unit is not cost effective with the current prices of the Envirotemp FR3 fluid and that of the other components. The learning will be kept on file and in case the price of the individual components of the innovative unit reduces substantially, the innovative unit idea could be revisited. Finally, the project revealed operational implications of using ester based fluids as an alternative to conventional mineral oil transformer units.

This may include recommendations of what form of trialling will be required to move the Method to the next TRL.

The reasons for halting the project are financial and not technical. Therefore, no recommendations for further trialing can be made.

The Network Licensee should also state if the Project discovered significant problems with the trialled Methods.

The identified issue is the fact that the manufacturing cost of the innovative transformer is higher than the manufacturing cost of the conventional mineral oil unit. As a result, and in reflection of the updated cost benefit analysis, SSEN has decided to halt the project.

The Network Licensee should comment on the likelihood that the Method will be deployed on a large scale in future.

It is SSEN's belief that with the current manufacturing cost of the transformer based on Envirotemp FR3 fluid, it is unlikely that the unit will be deployed at scale (i.e. replacing the use of standard mineral oil transformers over a substantial part of SSEN's replacement program over RIIO-ED1).

The Network Licensee should discuss the effectiveness of any Research, Development or Demonstration undertaken.

SSEN believes that the undertaken project resulted in a conclusive outcome in regards to the manufacturing of the transformer based on Envirotemp FR3 insulating fluid. Considering that the work undertaken informed DNOs about the financial viability of using Envirotemp FR3, the NIA project added value to the network operators and demonstrated effective use of customers' funds.

Lessons Learnt from NIA Project

Category 1: Technical Feasibility

No	Lesson Learnt Description	Recommendation
LL1.1	**Handling innovative insulating fluid:** The use of the proposed Envirotemp FR3 as an insulating fluid for transformers will complement existing practices of using mineral oil in the conventional transformer units. The introduction of new materials increases the maintenance and operations complexity. Areas that could be impacted are the procurement and storage of Envirotemp FR3, as well as the related risk mitigation and management practices (i.e. risk of mixing different fluids in the same transformer). The project identified early these areas that would be impacted and had factored them in the project plan, so they would have been addressed.	The impact of the innovative units or methods in the business as usual practices to be investigated and explored as early as possible within the project. Appropriate stakeholders to be identified and engaged early in the process. It is necessary to engage with operational personnel and engineering policy representatives who can advise on work instructions required and operational policies that would be impacted. All appropriate stakeholders shall then work together in order to develop appropriate mechanisms that would allow a transition of the innovative solution to the business as usual environment.
LL1.2	**Weather impact on innovative unit:**	

	The project identified that the performance of the Envirotemp FR3 (as a coolant) will be affected by low temperatures and mitigation plans would need to be put in place. These plans included the option of (a) geographically constraining the application of the innovative unit or (b) the provision of equipment and protocols that would enable the cold weather start. The key lesson learnt is that the weather conditions will most likely have an impact on innovative designs and needs to be taken into account.	The recommendation is for the weather impact (normal and extreme) to be taken into account when assessing the feasibility of an innovative design. In particular, it is recommended that the performance of all individual materials is assessed against normal and extreme weather conditions in order to ensure that they can cope with the environmental situations that will be encountered in an operational environment.

Category 2: Project Development & Management

No	Lesson Learnt Description	Recommendation
LL2.1	**Trial Site Selection:** Ester fluids provide an increased benefit in regards to the fire point and the environmental considerations (bio-degradable). The substation selected for the installation of the innovative unit was a substation that was scheduled for maintenance and replacement of transformers in the financial year 2017/18. Further to the above, the selected site was in need of Ester based transformers due to safety reasons. Therefore, it is concluded that the selected site offered both value for money and the necessary safety case to trial the innovative method on and thus maximizing the benefit to the customers.	It is recommended that a similar process is followed when selecting sites for the installation and trialing of innovative technologies. Taking into account the benefits to the customers and aligning the innovation opportunity with the need for planned maintenance maximizes the benefits to the customers and maintain the internal resources engaged in the innovative solution.
LL2.2	**Project Management methodology:** This project demonstrates the successful implementation of SSEN's project management methodology which involves gate reviews. The cost benefit analysis was updated in order to reflect the realizations from the detailed design of the innovative transformer and changes in the internal SSEN environment (updates in transformer frameworks). The updated cost benefit analysis demonstrated a change in comparison to the original one and triggered a project review which concluded in the decision to halt the project. Such decision is well justified as SSEN decided to halt a project with very low likelihood of achieving financial benefits. .	It is recommended that a similar project management approach is followed within other innovation projects characterized by high uncertainty. The benefits case which justifies the authorization of the project at the concept phase needs to be regularly reviewed in order to ensure that the project remains aligned with its benefits and no significant changes that threaten the benefits have materialised.

Note: The following sections are only required for those Projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

Project Background:

As discussed earlier in the report, the project completed the initial design and selection of innovative transformer and progressed with the detailed design of it. The detailed design and changes in the internal environment of SSEN (updated frameworks) resulted in an updated cost benefit analysis which demonstrated that the innovative transformer will not provide financial benefits to SSEN and the customers and as a result SSEN decided to halt the project.

Trial Site:

The site which had been selected for installing the innovative transformer unit was a primary substation which has 2 transformers that were planned to be replaced in the next financial year (2017/18). The substation was also in an

environment where the installation of an ester based transformer would benefit the safety case due to its location. Although the project will not be progressing, it is widely recognized by internal SSEN stakeholders that the site selection was successful, as it identified a site in need for an ester based transformer which is due for replacement in the near future and as such SSEN could maximize the value for money for the customers.

Innovative Transformer Unit:

Winder Power Ltd. had been tasked in reviewing available ester based fluids for use as the insulating medium of transformers and provided the design options to SSEN to decide which option to take forward. FR3 was found to be the least expensive ester fluid and was selected for further investigation.

Results and Outcomes:

Outcome 1 (Financial Implication): The manufacturing cost of the transformer with Envirotemp FR3 as insulating medium is higher than the cost of the standard mineral oil transformer with the current prices. Therefore, the Envirotemp FR3 would not be able to be rolled out in the wider SSEN network considering that this activity would be associated with a financial loss for SSEN and the customers.

- Base Cost which consists of the manufacturing and transportation of a standard mineral oil unit plus the associated oil containment that needs to be installed in the substation when using the standard transformer unit. Base Cost = £233,227.74

- Method Cost which consists of the manufacturing and transportation of an innovative transformer which uses Envirotemp FR3 as insulating medium. As this is an ester based medium, no oil containment would be needed and this is a saving of using the innovative transformer. Method Cost = £276,000.

- Financial Benefit = Base Cost – Method Cost = £233,227.74 - £276,000 = **-£42,772.26 (-18.3%)**.

Recognizing that this is an innovative unit and thus has an increased cost in comparison to a Business as Usual (BAU) product, the BAU cost of the innovative unit with Envirotemp FR3 as insulating medium has also been projected. The benefits case was improved in comparison to the project business case, but it still remains negative. Therefore, it is concluded that the innovative transformer unit based on Envirotemp FR3 will not be more cost effective in comparison to the standard mineral oil unit.

The reasons that constitute to the higher cost of the Envirotemp FR3 unit in comparison to the standard mineral oil unit are described below:

- There is a requirement for a vacuum tap changer to be fitted because of the difficulty of switching in high viscosity fluid at low temperatures. There were also limitations on the lowest operating temperature for the tap changer because of the fluid viscosity. Such requirement does not exist for the case of the standard mineral oil.
- The Envirotemp FR3 insulating fluid is approximately 2.35 times more expensive than the cost of the mineral oil and such fact adds to the increased manufacturing cost of the innovative unit. Further to the comparison with the mineral oil unit, it should be noted that the FR3 fluid was cheaper than all ester based insulating mediums investigated.
- A rubber bag/ membrane in the conservator is required for the Envirotemp FR3 insulating medium in order to seal it from contact with the atmosphere.
- In order to operate a higher temperature than mineral oil-filled transformers, some of the solid insulation in the proposed design needs to be of a higher temperature specification (thermally upgraded) and thus resulted in being more expensive than the base cost.

It is concluded that the design aspect that had the most cost implication was the fact that the transformer had to be designed in accordance with the EcoDesign regulations. Another factor was that the transformer needs to be sealed in order for the Envirotemp FR3 fluid to have no contact with the atmosphere. This is due to the properties of natural ester fluids, which will oxidise in the presence of oxygen and cause rapid sludging in the fluid.

All the above demonstrate that the Envirotemp FR3 unit would not be cost effective in order to replace the standard mineral oil units, which is the core scope and objective of the project, and the basis of the cost benefit analysis and benefits case upon which the project has been conceived and authorised.

Outcome 2 (Financial Implication): As part of the design phase of the project, a range of ester based fluids were investigated for being used as insulating mediums within the innovative transformer unit. It is demonstrated that the selected Envirotemp FR3 fluid has the lowest cost among all ester fluids investigated.

The following table demonstrates the comparison of the Envirotemp FR3 unit with other ester based fluids investigated and spans costing as well as other properties of the fluids.

Property	Envirotemp FR3	Midel En	Envirotemp 2000	Midel 7131	Shell Naturelle
Price (% of FR3)	100	110	135	180	215
Density (20°C) kg/dm^3	0.92	0.92	0.97	0.97	0.97
Viscosity (40°C) mm^2/s	32	37	29	29	27.2
Viscosity (0°C) mm^2/s	190	232			
Viscosity (-20°C) mm^2/s			1400	1400	1170
Flash point °C	320	327	270	260	255
Fire point °C	350	360	306	316	310
Breakdown voltage kV	78	75	73	75	72
Pour Point °C	-18	-31	-50	-60	-57

Table 1: Comparison of considered ester fluids[1]

Note 1: Some cells in the table 1 are blank due to the fact that the manufacturers quote the respective viscosity of the ester fluids in different temperature than the referred one. Synthetic esters have been quoted at -20 °C while natural esters have been quoted at 0°C, because they are highly viscous at -20°C.

Outcome 3 (Financial Implication): The eco-design regulations limit the amount of saving that could be achieved by reducing the active materials of a transformer (copper and core steel) due to the fact that losses would need to be comparable to those of a conventional mineral oil transformer.

One of the assumptions made at the project inception phase was the fact that ester based transformers would use less active materials (copper and core steel) than conventional oil filled transformers. This was primarily based on literature review of suppliers of ester fluids, who stated that more power can be passed through a transformer using ester fluid than for the equivalent oil filled transformer.

Upon a detailed review, this assumption was invalidated due to the fact that all transformers supplied into the UK are required to meet the Eco-design regulation. The regulation limits the amounts of losses that can be produced by the transformers, by imposing the obligation for transformers to meet the Peak Efficiency Index. The effect of increasing the rating of the transformer while keeping the active part materials the same, or conversely by reducing the active part materials (copper and core steel) and maintaining the throughput power, is to increase the losses at rated load, and this design strategy would have meant that the transformer did not meet the EcoDesign regulation, which is a legal requirement. SSEN also has a policy that new transformers should have lower losses or higher efficiency than the EcoDesign Tier 1 requirements, so there was little scope for reducing active part material. As the losses must be about the same as for a conventional oil filled transformer, there is limited scope in removing active materials from the transformer. There is some limited cost advantage in increasing the winding temperature by reducing the cooling ducts, and in decreasing the amount of cooling on the transformer, but this advantage was lower than initially anticipated and is offset by the additional cost of the Envirotemp FR3 fluid.

As a result, the project has demonstrated that the initial assumption has been invalidated and there is not a cost saving associated with the use of ester based fluids for transformer insulation.

Outcome 4 (Operational Implication): The pour point of the Envirotemp FR3 unit is much higher than the pour point of the standard mineral oil. That means that at higher temperature (-18°C in comparison to typically -57°C) the insulating medium would turn into a gel and would not be able to function properly.

In the UK there is a possibility of the temperature in extreme circumstances reaching below -18°C*, which is the temperature below which the transformer would not be able to operate. Although this probability is reduced in the Southern England (area of SEPD), it is much higher in the North Scotland (area of SHEPD). That means that the use of the innovative unit could be restricted to certain geographical areas or that the unit needs to be equipped with appropriate cold start protocols that would allow it to re-function once the pour point is reached. The latter option would have an impact on the finances of the solution.

The implication of the lower pour point is that the transformer should be operated at no-load for approximately 8 hours when started from cold at low temperatures (below -18°C). As a result, there could be a delay in re-connecting customers after an outage of several days in extremely cold weather, which would impact both the supply restoration to the customers and also the finances of the network operators (due to the Customer Minutes Lost penalties).

Another operational limitation is the fact that the tap changer should not operate when the temperature of the surrounding fluid is less than +5°C. Although there would be no restriction in loading the transformer at this temperature, it could cause problems in regulating the voltage of a transformer after an outage, even at normal UK winter temperatures.

Note (*): From high level review of historical data

Technology Readiness Levels

The current project aimed to develop the technology from TRL 6 to TRL 9. Considering that the project has been halted no progress in technology progress was made and as a result the TRL remain at the same level of 6.

Planned Implementation

The current project has been halted by SSEN due to the appreciation that the updated costs benefit analysis (undertaken after changes in the operational environment of SSEN and learning from the project) shows that the innovative transformer will not achieve the financial benefits forecasted. Therefore, there are no plans for implementing this technology. Should the costs of the primary materials as described earlier reduce significantly, SSEN would be revisiting the innovative transformer unit.

Other Comments

The documents below can also be requested by interested parties. Correspondence should be directed to SSEN.

- High Level functional specification of innovative transformer unit (based on Envirotemp FR3 unit).
- General Arrangement drawing of the innovative transformer unit.
- Rating Plate drawing of the innovative transformer unit.