

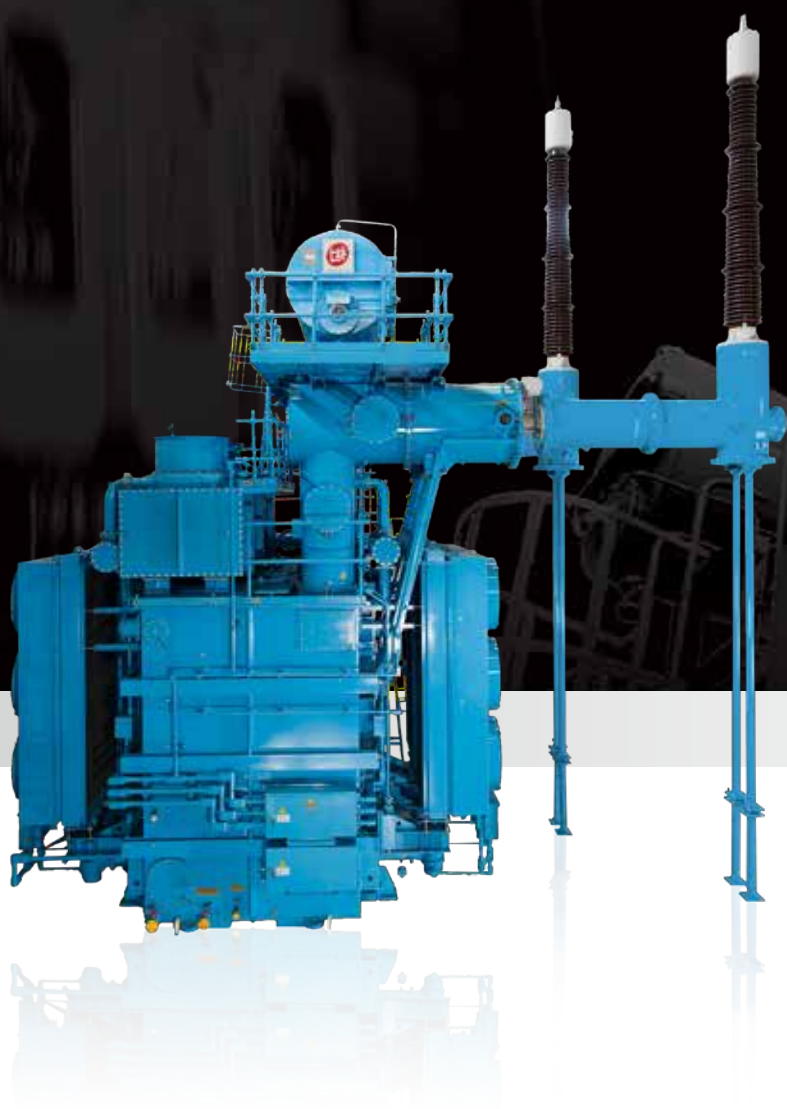


SHIHLIN ELECTRIC  
士林電機

2017.01 版

電力變壓器

# Power Transformer



工廠驗證



## INTEGRATION OF POWER SYSTEM

# Contents

一、發展沿革	
The Course of Change and Development	2
二、主要產品	
Main Products	3
三、製造能力&範圍	
Capability & Range of Manufacture	4
四、生產技術	
Manufacture Technology	5
五、開發技術	
R&D Technology	6
六、品質管理	
Quality Assurance	7
七、產品特色	
Characteristic of Products	
(1) 鐵心	8
The Cores	
(2) 繞組	9
The Windings	
(3) 外殼	10
The Tanks	
八、變壓器製程簡介	
Manufacture Process of Oil Immersed Transformer	11
九、主要國內客戶	
Main Domestic Customers	12
十、主要外銷客戶	
Main Export Customers	12



## 一、發展沿革

### The Course of Change and Development

1955年成立士林電工(股)公司，與三菱電機技術合作生產重電設備，歷年開發生產69kV級、161kV級、345kV級電力變壓器。於2003年完成台北世貿中心地下變電所161kV級60MVA SF6氣體絕緣電力變壓器開發，並於2006年積極大力擴展海外市場，另外，在於2014年完成國內345kV級最大容量三個單相420MVA(1260MVA)變壓器開發(台電核能三廠主變壓器)，50年持續不斷的改善,高可靠度經驗及優越的品質提供客戶滿意的產品及服務。

In 1955, Shinlin Electric Joint Stock Company made its first step to manufacture heavy-duty electrical equipments in collaboration with Mitsubishi Electric Corporation, and developed 69kV, 161kV, 345kV power transformers. In 2003, they successfully developed 161kV 60MVA SF6 Gas Insulation Transformer for underground transformer station of Taipei World Trade Center. In 2014, they successfully developed Three single-phase 345kV 420MVA (1260MVA) transformer-a type of maximum capacity in Taiwan, for Nuclear Power Plant(Maanshan Nuclear Power Plant). The 50-year-long relentless improvement, reliable expertise and superb quality enable them to deliver customized products and services.



重電廠 (Heavy Electric Plant)



## 二、主要產品 Main Products

- 345kV級(含)以下油浸式電力變壓器
- 161kV級(含)以下SF6氣體絕緣電力變壓器
- 爐用電力變壓器
- 整流用電力變壓器
- 移動式電力變壓器
- 電抗器
- 69kV油浸式比流器
- 69kV油浸式比壓器
- 69kV油浸式計費用整套型變比器
- 345kV (in cluding) and below oil Immersed Power Transformers
- 161kV (in cluding) and below SF6 Gas Insulation Transformers
- Furnace Transformers
- Rectification Transformers
- Mobile Transformers
- Reactor
- 69kV Oil Immersed Current Transformers
- 69kV Oil Immersed Voltage Transformers
- 69kV Oil Metering Outfits Transformer (MOF)





### 三、製造能力&範圍

#### Capability & Range of Manufacture

- 345kV級電力變壓器最大承製實績三相720MVA, 3個單相420MVA(1260MVA)  
設備承製能力三相1000MVA, 單相450MVA
- 230kV級電力變壓器最大承製實績三相336MVA自耦變壓器
- 161kV級電力變壓器最大承製實績390MVA, 設備承製能力500MVA
- 161kV級SF<sub>6</sub>氣體絕緣變壓器最大承製實績60MVA
- 69kV級電力變壓器最大承製實績220MVA
- 33kV級電力變壓器最大承製實績130MVA
- 各級特殊用途變壓器、電抗器
  
- 345kV power transformer: max. actual performance capacity : 3 phases 720MVA,  
Three single-phase 420MVA (1260MVA), rated capacity : 3 phases 1000MVA, 1 phase 450MVA
- 230kV power transformer: max. actual performance capacity 336MVA three-phase  
autotransformer
- 161kV power transformer: max. actual performance capacity : 390MVA, rated capacity : 500MVA
- 161kV SF<sub>6</sub> Gas Insulation Transformer: max. actual performance capacity : 60MVA
- 69kV power transformer: max. actual performance capacity : 220MVA
- 33kV power transformer: max. actual performance capacity : 130MVA
- Transformers and reactors for special purposes



鐵心自動積疊設備  
Automatic Core Stacking Equipment

## 四、生產技術 Manufacture Technology

### 嚴格作業環境管制、先進自動化設備

- 低落塵量、低濕度之繞線、心體組立廠房設備，從材料入廠、絕緣材料製造、線圈繞製、組立、鐵心剪切、積疊、心體組立、乾燥均於嚴格作業環境管制之防塵廠房中進行生產及裝配，確保異物入侵之防止。
- 先進瑞士製氣相乾燥爐全程電腦自動監控，使變壓器之心體均勻受熱，確保變壓器心體乾燥時之絕緣品質。
- 鐵心剪切全自動化，鐵心自動剪切機，配合鐵心自動積疊裝置，使鐵心加工劣化降至最低，確保良好之鐵心特性。

### Strict Control of Working Environment with Advanced Automatic Equipments

- To prevent foreign materials from entering dust-proof workshops, manufacture and assembly processing steps, such as incoming materials (windings of low dust and low humidity, core assembly equipments), manufacturing of insulation materials, winding and assembly of coils, shearing, stacking and drying of core, shall strictly follow the procedures in such working environment.
- State-of-the-art Swiss Vapour-Phase Drying equipment features computer-controlled automatic monitoring, thus providing uniform heating of transformer body and ensuring the insulating property of drying transformer body.
- Full automatic core cutting machine is able to minimize the processing deterioration of core and guarantee its excellent property, in collaboration with automatic core stacking equipment.



線圈繞製及組立廠房  
Coil Winding and Assembly  
Workshop



鐵心自動剪切設備  
Automatic Core Cutting  
Machine



氣相乾燥設備  
Vapour-Phase Drying  
Equipment

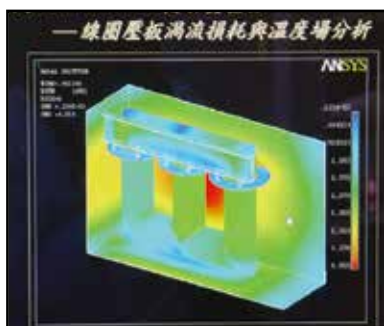
## 五、開發技術 R&D Technology

### 技術轉移、自主研發、軟體應用

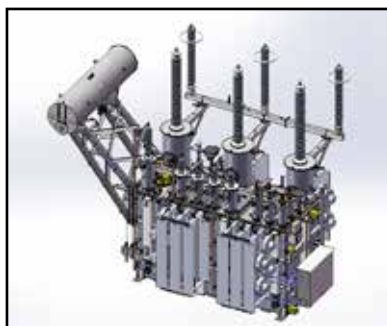
- 三菱電機技術轉移與士電研發處研發團隊支援，建立全方位研發團隊，與三菱電機技術同步，提供高信賴性之產品研發。
- 3D 電腦輔助設計軟體廣泛應用，結合CAE 軟體進行同步化設計開發。
- 阻抗計算、線圈短路機械耐力、磁界、線圈渦流損失之電腦解析程式驗證應用，可確實掌握變壓器內部應力場、電磁場效應。
- 有限元素解析軟體之應用、配合3D 電腦輔助繪圖軟體，可建構3D實體模型，進行3D實體之動態電磁場、應力場、耦合熱流場之解析模擬，達同步設計開發及驗證之境地。
- ATP DRAW軟體之應用，可做系統暫態模擬分析及電位分佈模擬分析。

### Technology Transfer and Independent R&D for Software Applications

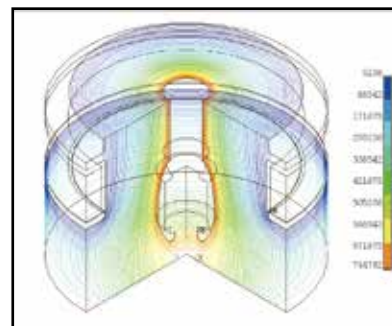
- With the transfer of up-to-date Mitsubishi Electric Corporation know-how and technical support of Shihlin R&D team, you're allowed to provide reliable products in tandem with Mitsubishi Electric Corporation technology.
- A wide range of applied 3D CAD software and CAE software guarantee a synchronized design and development.
- Through service test of computer aided analytic procedure including Impidance calculation, coil short circuit/mechanical endurance, magnetic field and coil eddy current loss, it's possible to really know transformer's internal stress field and electromagnetic field effect.
- With the applications of finite element analytic software and 3D computer aided drawing software, it's possible to build up a 3D solid model, carry out analytic simulation of 3D solid model's dynamic electromagnetic field, stress field and coupling heat flow field for synchronized R&D and proof test.
- ATP DRAW software application provides the system transient simulation analysis and potential distribution simulation analysis.



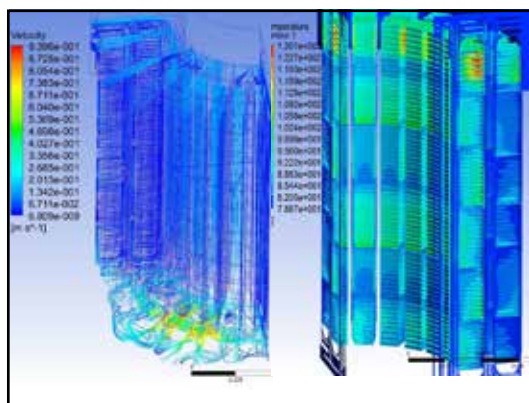
有限元素應用解析  
Applied Analysis of Finite Element



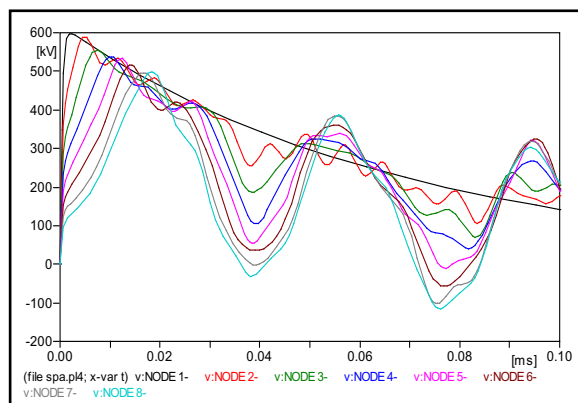
3D 電腦輔助繪圖軟體應用  
3D Computer Aided Drawing Software



電場強度分析  
Analysis of Electric Field Intensity



變壓器繞組熱流及溫度分佈分析  
Coupling heat flow field simulation



ATP DRAW軟體應用  
ATP DRAW software application



## 六、品質管理 Quality Assurance

### 完整自主檢核、精密高性能設備、ISO品質認證

- 精密充實之試驗中心、從進料到驗證驗收，為產品出廠作最嚴格之品質檢驗。
- 420kJ、2800kV高性能之衝擊試驗設備，提供最嚴格之絕緣耐力驗證試驗。
- 精密之油中氣體分析儀，可量測絕緣油中  $H_2$ 、 $CO$ 、 $CH_4$ 、 $C_2H_6$ 、 $C_2H_4$ 、 $C_2H_2$ 等可燃氣體之分析，提出最佳之絕緣油品質保證。
- ISO 9001、ISO 14001品質管制系統，在持續不斷的改善，提供顧客滿意的產品及服務品質政策下，提供客戶最完善的服務。
- 2006年通過中央標檢局OHSAS 18001工安認證，由產品生產至工地按裝，均接受最嚴格的工安管制。
- 2007年通過大陸瀋陽變壓器研究所對110kV 40/50/60 MVA power transformer品質測試認證。
- 2010年通過TAF ISO 17025測試實驗室認證。
- 2011年全台第一家上市公司通過經濟部能源局高壓用電設備原製造廠家認證。



2800kV 衝擊電壓試驗設備  
2800kV Impulse Testing Equipment.



油中氣體分析儀  
DGA Analyzer

### Check Independently High-Performance Precision Equipments with ISO Quality Certificate

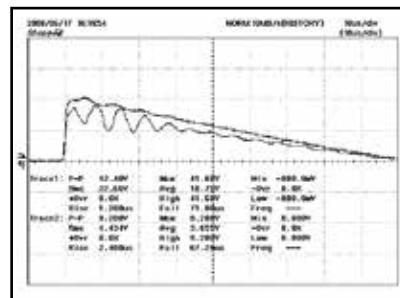
- High-performance test center allows you to implement strictest quality inspection from input to ex-factory verification and acceptance check.
- 420kJ、2800kV high-performance impulse testing equipment provides strictest proof test of insulation endurance.
- The DGA analyzer can analyze total combustible gases, e.g.  $H_2$ 、 $CO$ 、 $CH_4$ 、 $C_2H_6$ 、 $C_2H_4$ 、 $C_2H_2$ , etc., in insulating oil, thereby providing optimal quality assurance of insulating oil.
- ISO 9001 and ISO 14001 quality control systems continuously improve their policies for delivering perfect products and services to satisfy the customer demands.
- We have OHSAS 18001 industrial safety certification awarded by BSMI(Taiwan) in 2006. From product manufacturing to site installation are strictly conform to industrial safety management.
- Quality test certification of 110kV 40/50/60MVA power transformer was approved by Shen Yang Transformer Research Institute(China) in 2007.
- Pass the TAF ISO17025 Testing Lab Certification in 2010.
- The first Taiwan listed company to pass the certification of high voltage electrical equipment original manufacturer of Bureau of Energy, Ministry of Economic Affairs, R.O.C. in 2011.



品質試驗中心  
Quality Test Center



溫升試驗用進相電容器塔  
Phase advance capacitor tower for temperature rise test



電位分佈模擬解析  
Potential Simulation Analysis



## 七、產品特色 Characteristic of Products

### (1) 鐵心 The Cores

具低損耗、低噪音、高短路機械耐力

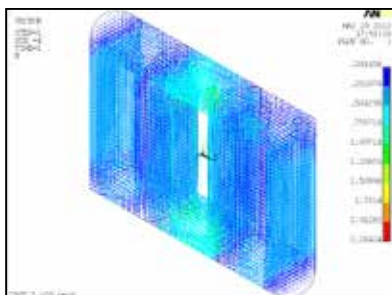
- 高導磁率、低磁滯損之矽鋼片，採全自動剪切及積疊設備，充分維持原材料固有之優良特性。
- 鐵心表面皆經過絕緣膜處理、增加層間絕緣電阻，減少渦流損，確保鏽蝕之防止。
- 先進之V-NOTCH及 STEP-LAP 塔接式疊積、輔以玻璃纖維帶 (glass band) 束緊，使具高短路機械耐力及低噪音之優良特性。
- 梳子型之夾件結構、可有效降低洩漏磁通之侵入量，輔以有限元素模型解析鐵心磁路及疊積氣隙之磁通量，可充分掌握鐵心磁路特性，使變壓器鐵心結構具有低損耗之優良特性。

#### Low Loss, Low Noise and High Short-Circuit Mechanical Endurance

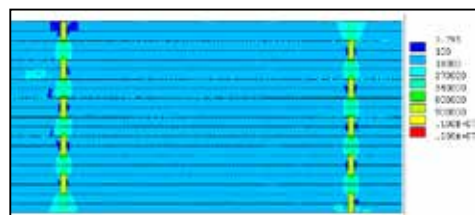
- Full-automatic cutting and stacking equipments have adopted silicon sheet of high magnetic inductivity and low magnetic hysteresis loss, thus maintaining inherently excellent properties of raw materials.
- Through applying insulation film onto core surface, increasing layer insulation resistance and reducing eddy current loss, it's possible to prevent corrosion.
- Advanced V-NOTCH and STEP-LAP lapped-type stacking with glass band can ensure exceptional properties of high short-circuit mechanical endurance and low noise.
- Rake-type clamping construction can reduce efficiently the inrush current of leakage magnetic flow. Moreover, through analyzing core magnetic circuit and air space's accumulated magnetic flow via finite element model, you're assured of the features of core magnetic circuit and low loss characteristics of transformer core construction.



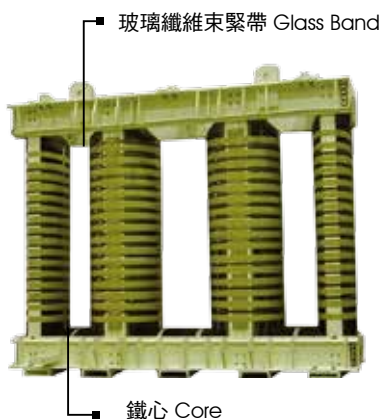
梳子型夾件  
Rake-type Clamping Construction



鐵心磁場分析  
Analysis of Magnetic Field

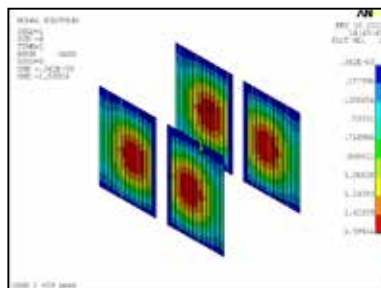


鐵心間隙區磁場強度分佈圖  
Distribution of Magnetic Field Intensity in Core Clearance Region

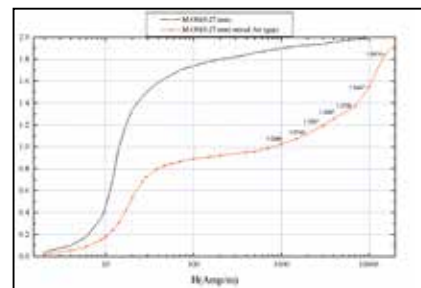


玻璃纖維束緊帶 Glass Band

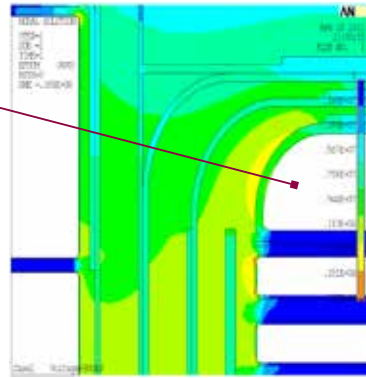
鐵心 Core



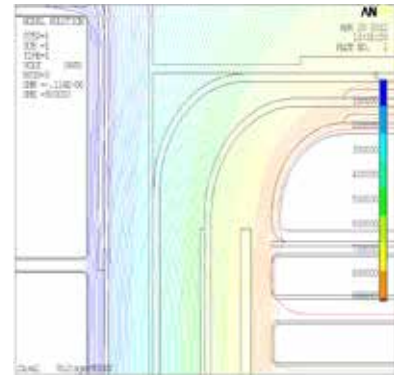
遮蔽鐵心磁通密度分佈圖  
Shielded Core Magnetic Flux Density Distribution



鐵心氣隙B-H曲線分析  
Core Air Space B-H Curve Analysis



電場強度分布圖  
Electric Field Intensity Distribution



等位線分布圖  
Distributions of the Equipotential Lines

## (2) 繞組 The windings

具高耐突波能力、高短路機械能力

- 端部靜電環及R型絕緣結構、可充分吸收外部突波之能量、並透過繞組內部之電位振動模擬解析，充分掌握繞組之電位分佈情況進行最適當之絕緣配置。
- 繞組內部油道設計、精準之絕緣物加工，避免擾流現象、使油流順暢，散熱均勻快速，確保變壓器在長期使用之絕緣品質。
- 繞組之導體選用、橫向、縱向之油路配置，均經過周詳之繞組間安匝平衡計算、並使用計算機軟體精準計算短路時之繞組應力分佈、繞組導體承受應力、提供充分之繞組耐短路機械能力。



油道結構  
Construction of Oil Duct

**Available with high abrasion-resistance and surge capacity as well as high short circuit mechanical endurance.**

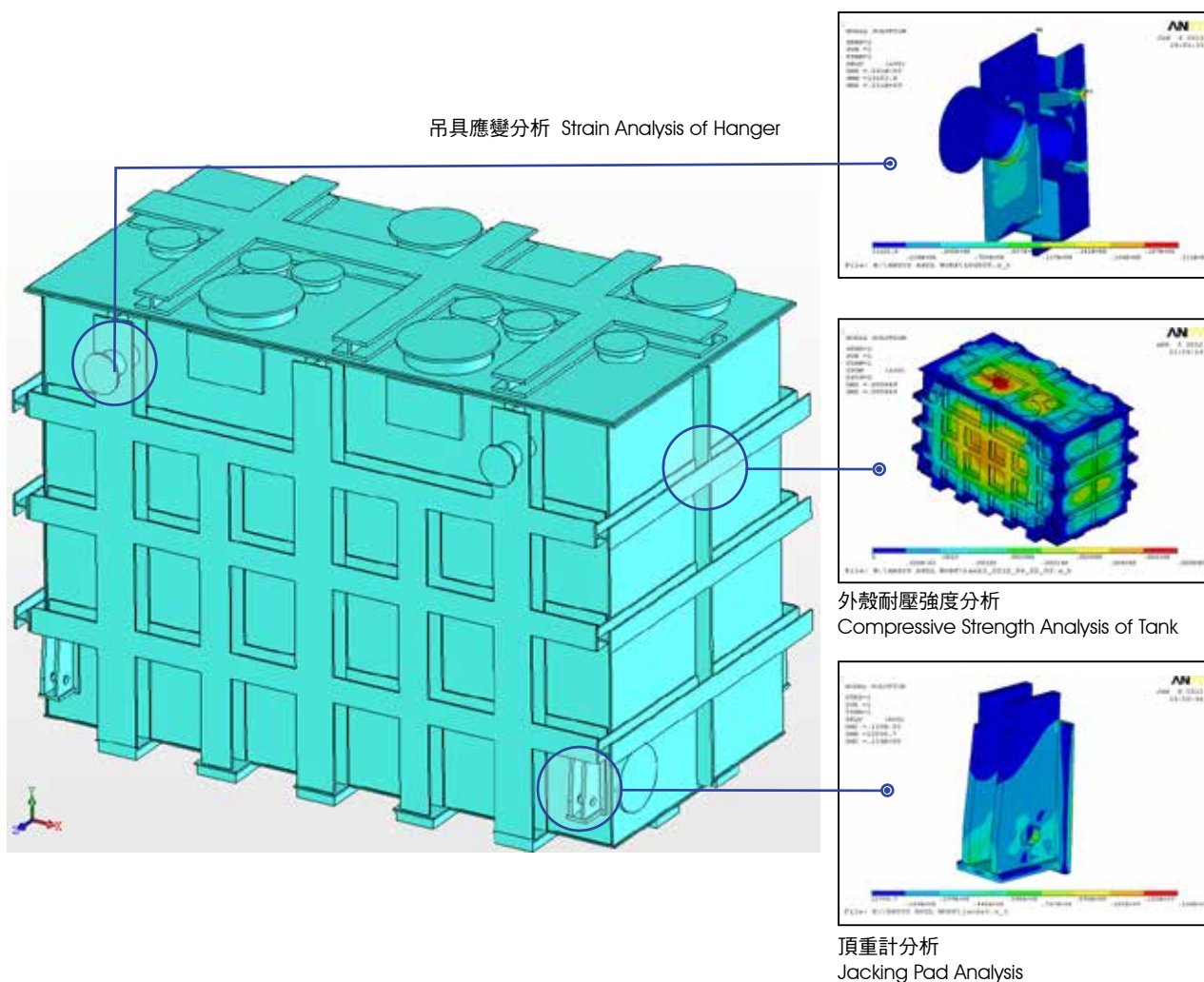
- End electrostatic ring and R-type insulation construction can fully absorb the energy of external surge. And, based upon potential vibration simulation analysis within the winding, you can fully understand potential allocation of windings for optimized insulation configuration.
- The winding's oil duct design provides accurate processing of its insulant and avoids current interference. thus, efficiently controlling conductivity of oil flow and ensuring a long-term insulation property of transformer.
- The selection of winding conductors and horizontal / longitudinal layout of oil duct shall be subjected to detailed balance computation of installed windings. And, computer software are applied for stress distribution of windings and endurance of winding conductors in order to provide a desirable short-circuit proof mechanical endurance for the windings.



計算機應用  
Application Program

### (3) 外殼 The Tanks

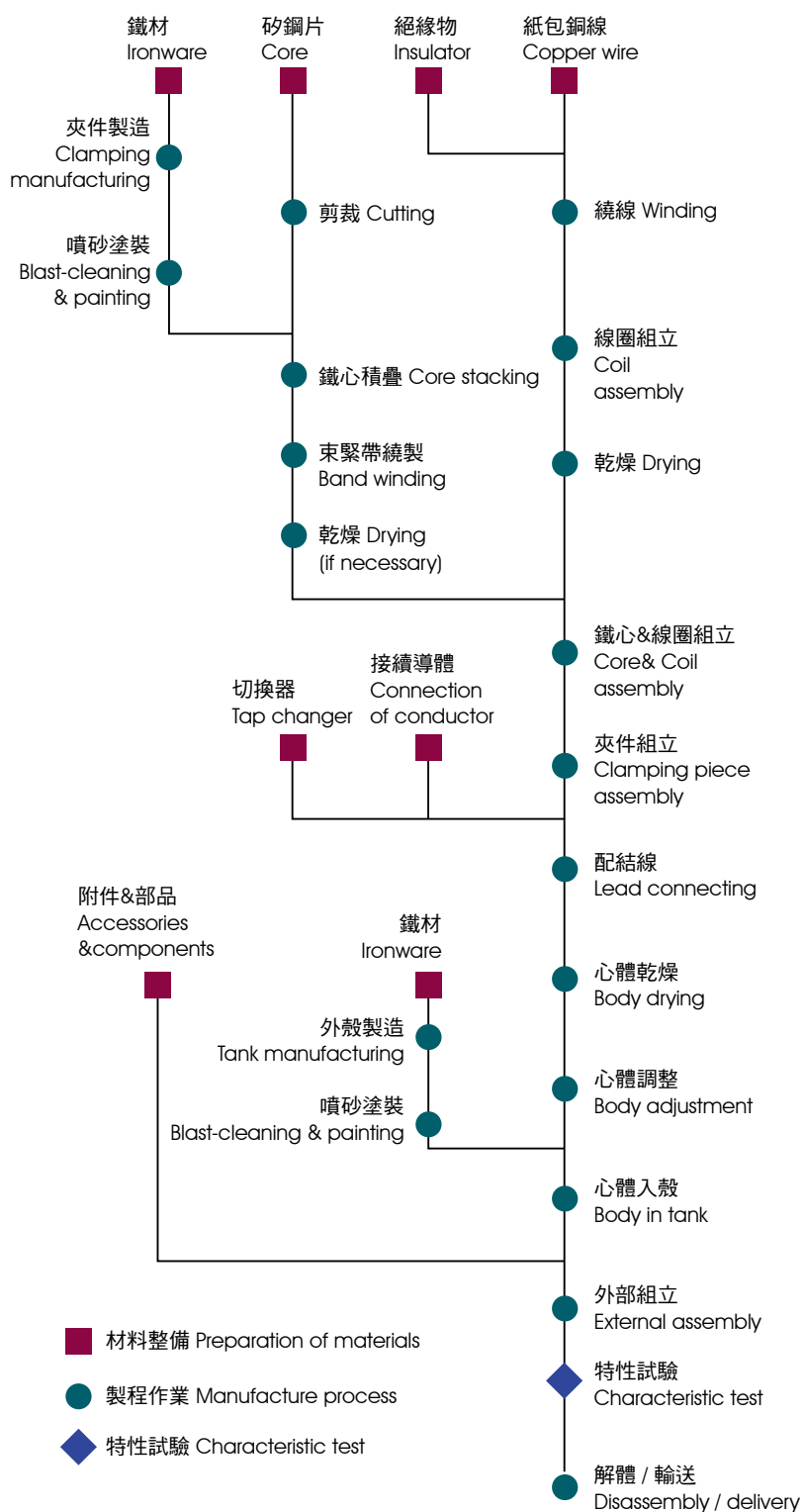
- 外殼殼體、相關附件皆進行氣密試驗，確保殼體及附件之洩漏防止及耐壓強度。
- 外殼殼體、相關附件在重點結構處採用有限元素進行3D實體模型之應力、應變解析可充分確保外殼之耐壓強度。
- The tanks and relevant accessories shall be subjected to leakage test and its accessories and ensure sufficient compression strength.
- The stress and strain analysis of 3D solid model via finite element shall be performed at important constructions of the tanks and relevant accessories, with its aim of fully guaranteeing the compression strength of the tanks.





## 八、變壓器製程簡介

## Manufacture Process of Oil Immersed Transformer



線圈組立 Coil assembly



心體組立 Body assembly



心體乾燥 Body drying



心體入殼 Body in tank



特性試驗 Characteristic test