Dimensional Control Survey Proposal

Ver. Date : 2017.06.15
Our Business

World’s #1 Dimensional Accuracy Control Technology

Accurate
• +/- 1mm (1/24”) Accuracy
• 0 failures in First Time Fit

Fast
• 50% faster than other leading technologies

Know How
• 10 years of consulting in Dimensional Control and Dimensional Control ONLY!

Onshore Plant
Modular Construction
Single Weld Hook Up
After Installation Check
Erection Simulation

Offshore Plant & Shipbuilding
Prefabrication Check
As built vs Design comparison
As built vs As built clash detection

Buildings & Steel Structures
Revamp
Retrofit
Renovation
Why is Dimensional Control so important?

Small accuracy errors accumulated during pre-fabrication lead to huge problems during installation.

Re-work on module installation stage increases danger of industrial accidents, and cause decline of work efficiency.

Objective of Dimensional Control: First Time Fit
## Dimensional Accuracy Control in Modular Construction

Most measurements are taken without stopping work process

### Construction Phase

<table>
<thead>
<tr>
<th>What we offer</th>
<th>How Fast we do it</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimension Check</strong></td>
<td>Measured while being built</td>
</tr>
<tr>
<td>• Design vs build control to minimize errors in pre-fab</td>
<td>1~3 Checks per module</td>
</tr>
<tr>
<td>• Pipe Spool clash check using as built vs as built clash check simulation before transportation</td>
<td>2~3 hours per check</td>
</tr>
<tr>
<td><strong>Clash Detection</strong></td>
<td>Measured while being built</td>
</tr>
<tr>
<td>• Check for deformation after transport</td>
<td>1 day : Pipe Rack (~80 spools)</td>
</tr>
<tr>
<td>• Check proper installation of the module to prepare for next installation</td>
<td>1<del>3 days : 4</del>500 Ton</td>
</tr>
<tr>
<td><strong>Deformation Check</strong></td>
<td>Measured before installation</td>
</tr>
<tr>
<td>• Check for deformation after transport</td>
<td>1 week : 2,000 Ton+</td>
</tr>
<tr>
<td><strong>Installed Module Check</strong></td>
<td>Measured while positioning module</td>
</tr>
<tr>
<td>• Check proper installation of the module to prepare for next installation</td>
<td>1~2 Hours</td>
</tr>
</tbody>
</table>

### Pre-Fabrication

- Assembled Work

### Assembled Work

- After Transport

### After Installation
Dimensional Accuracy Control in Modular Construction

Pre-Fabrication: Minimize errors during assembly quickly

Average Error Occurrence: 16~37%

1~3 Measurements per module
2~3 hours per measurement
Errors are caught and corrected without interruption

How we do it

Measured while being built → Simulation → Instant Comparison Report

Solved by:

Error from cutting
Error from welding
Assembly Error
Dimensional Accuracy Control in Modular Construction

Detect & Fix errors before transporting the module

Around 70% mis-alignments occur during installation leading to increased safety hazard & cost

1 measurement
1 day per measurement
Errors are caught and corrected without interruption

How we do it

Scan adjoining area → Simulation → Clash Report

- Not Good Fix before Transport
- Good Ready for Transport
Dimensional Accuracy Control in Modular Construction

Deformation check after transport

20% of modules are deformed during transportation

Damages incurred from Lifting and Transporting

1 Measurement
1~2 hours per measurement
Stand by time : 2hrs

How we do it

Measure Target Coordinates
Module A
Module B
Comparison Simulation
Clash Report

Not Good
Fix before Install
Good
Ready to Install
**Dimensional Accuracy Control in Modular Construction**

**Installation Check**

Without Dimensional Accuracy Control angle error, positioning error occurs 99% of time.

Wrong Angle, Tilting to one side

1 Measurement

1~2 hours per measurement

Stand by time: 2 hrs

**How we do it**

Measure and check Angle, Vertical Position, and Level while setting the module.
Samin’s Core Competency: Accuracy, Speed, Knowhow

10+ years of technological advancement in Dimensional Control

More than 50% Faster

Client Request
Laser Scanning
Registration

SAMIN

1 Day
1 Day
Not Needed
0.5 Day

3D Modeling
Dimension Check/Simulation
Report

Working Time: Max. 3 Days

Others

1 Day
1 Day
3 Days
1 Day

Working Time: Max. 6.5 Days +
Single Weld Hook UP
Realistic View
**SWHU in Modular Construction**

First Time Fit on site is achieved through Single Weld Hook Up (SWHU)

- SWHU : Conjoining pipes without using Pup piece and only welding in a single area
Reality in today’s SWHU

Theoretically, SWHU should reduce cost and resources by 50% or more

Reality: Construction companies spend millions of dollars extra to implement SWHU due to lack of experience and right tools. (No single company achieved 100% SWHU as of today)
Reality in today’s SWHU

What companies are doing:
Mix of Stick Built, ‘Pup Piece’, and SWHU (20~50%)

Creating ‘Reserve’
to make room for mis-alignment
SWHU in Samin Dimensional Control - Benefit

Case without Samin Dimensional Control

Company A spent $4million on design change and $4million+ more extra installing the modules

<table>
<thead>
<tr>
<th>PKG</th>
<th>STEEL STRUCTURE</th>
<th>PIPING</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-assemble</td>
<td>Modularized</td>
<td>Pre-assemble</td>
</tr>
<tr>
<td>PKG A</td>
<td>900 Ton 27 EA</td>
<td>5,800 Ton 61 EA</td>
<td>1,500 Ton</td>
</tr>
<tr>
<td>PKG B</td>
<td>4,000 Ton 34 EA</td>
<td>3,700 Ton 89 EA</td>
<td>2,300Ton</td>
</tr>
<tr>
<td>PKG C</td>
<td>400 Ton 4 EA</td>
<td>2,000 Ton 22 EA</td>
<td>-</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5,300 Ton</td>
<td>11,500 Ton</td>
<td>3,800 Ton</td>
</tr>
</tbody>
</table>

With Samin Dimensional Control

Design change is minimized, and can apply SWHU on most installations (80%+) at fraction of the cost
References & Case Studies
## Project Reference

<table>
<thead>
<tr>
<th>Project</th>
<th>Year</th>
<th>Work Scope</th>
<th>RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-Oil RUC Project</td>
<td>2016~2017</td>
<td>• 3rd Party Dimensional Inspector of Project Owner&lt;br&gt; • HS FCC Vessel Dimensional Inspection&lt;br&gt; • HS FCC Vessel Installation Simulation &amp; Inspection</td>
<td>• Scanner : Leica C10, P30&lt;br&gt; • Total Station : Leica MS 50&lt;br&gt; • Pre Process : Cyclone&lt;br&gt; • Inspection &amp; Simulation S/W : EcoPASS, EcoInspection (Specialized Dimensional Control s/w dev. by SAMIN)</td>
</tr>
<tr>
<td>LNG Plant Project</td>
<td>2015</td>
<td>• LNG Plant Module and Vessel Dimensional Error Analysis&lt;br&gt; • Dimension Check for 600ton, 2000ton, Column&lt;br&gt; • Module and Vessel Installation Simulation</td>
<td>• Scanner: Leica P20&lt;br&gt; • Data Process : Cyclone&lt;br&gt; • Analysis &amp; Simulation S/W : EcoPASS, EcoInspection (Specialized Dimensional Control s/w dev. by SAMIN)</td>
</tr>
<tr>
<td>CBDC Plant Project</td>
<td>2013</td>
<td>• Large Column (External/Internal) Dimensional Inspection&lt;br&gt; • Flatness of Skid Base, Nozzle Orientation, Straightness, Roundness &amp; Internal Tray Dimensional Accuracy Comparing 3D Design and 3D Laser Scanning Data</td>
<td>• Scanner : Leica P20&lt;br&gt; • Data Process : Cyclone&lt;br&gt; • Inspection S/W : EcoInspection (Specialized Dimensional Control s/w dev. by SAMIN)</td>
</tr>
<tr>
<td>Gorgon LNG Plant Project</td>
<td>2012~2013</td>
<td>• Providing 3D Dimensional Control Solutions and Laser Scanner&lt;br&gt; • Technical Training for Shop and Site Survey using Laser Scanner and Total Station&lt;br&gt; • Technical Training for Dimensional Error Analysis using Software Solution</td>
<td>• Scanner: Z+F IMAGER 5010C&lt;br&gt; • Total Station : SOKKIA NET&lt;br&gt; • Inspection S/W : EcoInspection, EcoBLOCK, EcoOTS (Specialized Dimensional Control s/w dev. by SAMIN)</td>
</tr>
<tr>
<td>Semi-Sub Project</td>
<td>2011~2012</td>
<td>• Technical Training for Preparing Dimensional Control Procedure &amp; Field Application of 3D Dimensional Control Solution&lt;br&gt; • Providing 3D Dimensional Control Solution</td>
<td>• Total Station : SOKKIA NET&lt;br&gt; • Inspection S/W : EcoBLOCK (Specialized Dimensional Control S/W dev. by SAMIN)</td>
</tr>
</tbody>
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<th>Project</th>
<th>Year</th>
<th>Work Scope</th>
<th>RM</th>
</tr>
</thead>
</table>
| Prelude FLNG Project  | 2014~2015    | • Clash Check: Topside Module integration to hull  
• Project Range: 12 Modules + 1 Flare Tower  
• Report to Owner & Construction Company: Clash, Dimensional Error, Tight Gap | • Scanner: Leica C10  
• Data Process: Cyclone  
• Clash Check S/W: EcoPASS (Specialized Dimensional Control S/W dev. by SAMIN) |
| Q-204 FPSO Project    | 2013         | • Lower Turret Installation Simulation  
• Gap and Clash Check When Lower Turret is located to the certain critical elevation. (Hull: 3 Elevations/ Lower Turret: 3 Elevations)  
• Report to Owner & Construction Company | • Scanner: Z+F IMAGER 5010C  
• Data Process: Cyclone  
• Simulation S/W: EcoPASS (Specialized Dimensional Control S/W dev. by SAMIN) |
| Spar Hull Project     | 2016         | • Spar Hull Dimensional Error Analysis and Erection Simulation  
• 50m Diameter sized Cylinder Structures Dimension Check and Structure Alignment Check | • Scanner: Leica P40  
• Data Process: Cyclone  
• Inspection S/W: EcoPass (Specialized Dimensional Control S/W dev. by SAMIN) |
| Jackup Project        | 2013~2014    | • Technical Training for Preparing Dimensional Control Procedure & Field Application of 3D Dimensional Control Solution  
• Providing 3D Dimensional Control Solution | • Total Station: SOKKIA NET  
• Inspection S/W: EcoBLOCK (Specialized Dimensional Control S/W dev. by SAMIN) |
| Shanghai Tower        | 2013~2014    | • Utilizing 3D Dimensional control software for Shanghai landmark dimensional quality control | • Total Station: SOKKIA NET  
• Inspection S/W: EcoBLOCK (Specialized Dimensional Control s/w dev. by SAMIN) |
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<tr>
<th>Project</th>
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<th>Work Scope</th>
<th>RM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMSUNG Display Factory Modeling</td>
<td>2016</td>
<td>• As-Built 3D Modeling Project                                                                                                                   • Factory Scale : 310×110×5m 7stories LED factory</td>
<td>• Scanner : Leica C10, P30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 15 Years old factory ; Less factory drawing information.                                                                                       • Compare the existing drawing and present state</td>
<td>• Pre Process &amp; Modeling : Cyclone</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Verify the area need to be replaced and added.</td>
<td></td>
</tr>
<tr>
<td>Heavy Structure Inspection (Huisman-Yard)</td>
<td>2016~2017</td>
<td>• Dimensional Inspection for mega sized crane equipment. (HEEREMA 10,000T Crane, Boskalis 300 0T offshore platform truster etc.)</td>
<td>• Total Station</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Inspection S/W : EcoMES,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EcoBlock (Specialized Dimensional Control s/w dev. by SAMIN)</td>
</tr>
<tr>
<td>Building Inspection</td>
<td>2014</td>
<td>• Dimensional Inspection for irregular shaped building comparing Design and 3D Scanning Data                                                        • Dimension check for columns and roof</td>
<td>• Scanner : Leica C10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Providing Inspection Report.</td>
<td>• Data Process : Cyclone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Inspection S/W : EcoPASS (Specialized Dimensional Control S/W dev. by SAMIN)</td>
</tr>
<tr>
<td>Macau Hotel Tower</td>
<td>2014~2015</td>
<td>• Providing 3D Dimensional control inspection service for building module dimensional error analysis</td>
<td>• Total Station : SOKKIA NET</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Inspection S/W : EcoBLOCK (Specialized Dimensional Control s/w dev. by SAMIN)</td>
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<tr>
<td>HuTong Bridge</td>
<td>2015~2016</td>
<td>• Utilizing 3D Dimensional control software for China railway bridge dimensional quality control</td>
<td>• Total Station : SOKKIA NET</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Inspection S/W : EcoBLOCK (Specialized Dimensional Control s/w dev. by SAMIN)</td>
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</table>
Offshore Plant - FLNG

- Project Summary: The World's Largest Ship – FLNG Topside Module Clash Check Simulation
- Project Purpose:
  - Spools, pipes, a lot of outfitting on module are temporarily placed, also there are a lot of scaffolding and cable support, so it is not easy to forecast the expected location of clash after the erection.
  - Because of safety reason it is not allow anybody to enter and do any modification work in PE place.
  - All modification works should be done in fabrication location after the modules is brought back if any clash happens.
Offshore Plant - FLNG

1. Original Topside Module Clash Detection Process

① Clash Check
Clash check using 3D design model

② Erection & Remove Clash parts
Clash ?

- Cost
  - Erection

- Standby
  - Remove clash parts

- Unsafe
  - Clash ??

- Inaccurate
  - Check the clashes for different parts using tape

- Delay
  - Design
  - Find difference
  - On-site

- Delay
2. Samin produced accurate Clash Detection simulation and report within 5 days per module (Competitor’s estimate was 3 weeks per module)

- Gathered accurate measurement using 3D scan
- Used Samin solution to prepare accurate simulation data
- Shared the result of simulation with production team.
- Determined where to remove and modify structure parts
- No interruption during fabrication
3. Conclusion

- Achieved 0 clash in all 13 modules
- Module erection time was reduced from 12 hours to average 3hrs (The shortest 40mins)
- Saved millions of dollars (ROI of 2,000%)

https://www.youtube.com/watch?v=F_xm5Ku5Nj8
Competitor Comparison

Some companies are proud of...
- Spending 8 days two person team for measuring 800 scan positions
- Spending 21 days 1 person scan positioning registration
- To produce only the Registered point cloud and TruView

For comparing ‘design of gas plant’ with ‘to be integrated existing structure’

If they came to Samin, they would’ve had “Clash Simulation” result within 11 days!
One more thing...
Samin Price Competitiveness

Costs **40%** less per day/person than F company

Costs **10%** less per day/person than A Company

**More than 50%** Faster output than competitors
Appendix

- Company History
- How Dimensional Control is conducted in Korea
- Process Flow
**History**

<table>
<thead>
<tr>
<th>Name</th>
<th>SAMIN Information System Co.,Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Founder</td>
<td>DH Yoon, DE Kim, KW Kang</td>
</tr>
<tr>
<td>Address</td>
<td>#505 Centum SH Valley, U-Dong, Haeundae-Gu, <strong>Busan, Korea</strong></td>
</tr>
<tr>
<td>Contact</td>
<td>Tel) +82 70 7771 2104</td>
</tr>
<tr>
<td><strong>Email</strong></td>
<td><a href="mailto:jskim@saminis.com">jskim@saminis.com</a></td>
</tr>
</tbody>
</table>

**Establish R&D Center**

**Establish China(Shanghai) Office**

**Patent Registration in Korea**

**The First consulting contract with China State-owned Enterprise**

**Contract with the world best shipyard in Korea**

**The first contract in Brazil**

**The First contract in Singapore**

**The First consulting contract with China State-owned Enterprise**

**Certificate of Good Software**

**Certificate of World Class Product of Korea**

**“EcoPASS” Patent Registration in Korea**

**Patent Registration in Japan**

**The 2nd consulting contract in China**

**Patent Registration in China**

**Release “EcoStructure”**

**Release “EcoInspection”**

**Release “EcoSystem”**

**The First contract with the largest Japan Shipbuilding Group**

**Release “EcoMarine G2”**

**The First contract with Vietnam State-owned Enterprise**

**Table 2006 to 2015**

**2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015**
How Dimensional Control is conducted in Korea

- Conduct dimensional accuracy inspection of all block/module at the end of each stage.
- Defects found are not released to next phase.
- Korean heavy industries companies sporadically conduct dimensional accuracy inspection.
- Dimensional accuracy control policy enabled Korean heavy industries companies to build high quality of mega sized blocks and modules.

Root cause investigations
- Resolve
- Maintain the flow of work
3D Dimensional Control Management Method

1. Prepare Dimensional Control plan for each module fabrication stage
   - Select proper management methodology, device, and software for each stage and module type.

   - **Small size assembly – Manual Check**
   - **Mid to Large Size Assembly – 3D measurement**
     - (Length, Vertical degree, Level, Deformation check)
   - **Erection/Installation – 3D measurement**
     - (Datum point based erection/installation simulation S/W)

   - **Round and complicated structure**
     - (3D laser scanning Dimensional Control S/W)

   - **Set datum points and direction of final module installation**

   - **Control Points**
     - Understand installation drawing:
       - Installation direction (E, W, S, N)
     - First Time Fit control (Module Direction)
     - Module installation – Relation Control
     - Fix the base line, Module
     - Having a same base line (Ex: West/Bottom)
     - Ground marking: 1~2mm
     - Pendulum on Beam: -3mm (Height/Length)
     - Bottom joint part control
     - Level Control
     - Based on Center control the coordinate
     - Out Side – back heating
     - All component control (e) from Unit Assembly stage considering shrinkage.
     - Tech welding for Joint part, keep the gap for shrinkage.
     - Welding Shrinkage: 1mm – 0.5mm
     - Punching - Base Point & Center Line
2. Acquisition of dimensional data of fabricated modules

- Determine the equipment type and method based on structure type and management point.
3D Dimensional Control Management Method

3. Measurement Analysis

- Verify As-Built measurement against design and tolerance
4. Module Erection/Installation Simulation

- Clash detection simulation using gathered data
- Plan best path and location for module installation/erection
- Modify any clash points before installation/erection
- Apply weight offset value during operation as needed

3D Dimensional Control Management Method
5. Dimensional Control during Module Installation/Erection

- Simulation based module installation/erection check
- Verify the position and setting of module during installation/erection
6. Module As Built Data Analysis and Management

- Check metal expansion/shrinkage after welding using phase based measurement data
- Analyze measured data against tolerance level
- Periodic deformation check during operation and transport
- Utilize data gathered during maintenance, revamp, and retrofit

<Statistical analysis of phase based measurement>

<As-Built data utilization>
Utilize SAMIN Software Solution to Process Flow

1. Design Model, Point Cloud Viewing & Dimension Check
2. Accuracy Analysis using measurement data and design model
3. Assembly simulation
4. Drafting
5. Data and work management/sharing

SAMIN Solutions

3D Design Model
Laser Scanning Data (Point Cloud)
Total Station Measurement Data

AVEVA PDMS Tribon
SmartPlant 3D
Utilize SAMIN Software Solution to Process Flow
Q&A

Thank you.

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