QUALITY ASSURANCE MANUAL
AND
QUALITY CONTROL

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INTRODUCTION

The director of steel tower business headquarters of AG AJIKAWA CORPORATION assumes full responsibility for conformance to client’s specifications, standards and laws relevant to tower manufacturing, as well as to all the requirements of Quality Assurance Manual.

The director of coating business headquarters of AG AJIKAWA CORPORATION assumes full responsibility for conformance to client’s specifications, standards and laws relevant to galvanizing, as well as to all the requirements of Quality Assurance Manual.

Quality Management Representative is authorized to enforce and revise Quality Assurance Manual and is responsible for solution of quality assurance problems.

This Quality Assurance Manual has been prepared so that every staff of AJIKAWA may insure quality products as stipulated in this manual.
SECTION 1. GENERAL ITEMS OF QUALITY ASSURANCE PROGRAM

1.1   ORGANIZATION CHART

1.1.1 ORGANIZATION CHART OF STEEL TOWER BUSINESS HEADQUARTERS
1.1.2 ORGANIZATION CHART OF GALVANIZING DIVISION

Director of coating business headquarters

Quality management representative

Manager of galvanizing division

Manager of business control department

Manager of Osaka plant

Purchasing manager

Quality assurance manager

No.1 business section

No.2 business

No.3 business

Galvanizing section

Process control section

Facility control section

Technical section

- Checking quality status
- Quality control of galvanizing products
- Reception of product order
- Confirmation of contract contents
- Receiving claims from customers

- Galvanizing of products
- Daily schedule control
- Itemization, packing, forwarding and shipment of products
- Maintenance of processing facilities
- Technical process control
- Technical (chemical) analysis of products
- Order placement of raw materials and verification
1.2 MANAGEMENT OF THE QUALITY ASSURANCE PROGRAM

1.2.1 Quality Assurance Manager shall control and assist plants and their staff so that every operation may be performed in accordance with QUALITY ASSURANCE MANUAL.

1.2.2 QA Manager shall make periodical review of this manual and insure all the staff involved is informed of its revisions.

1.2.3 Fabrication Manual, Purchasing Specifications, Drawings, Work Instruction, etc. shall provide for permissible tolerances, inspection criteria, etc.

1.2.4 Errors on client's drawings and documents detected by AJIKAWA shall be reported to clients immediately and the relevant records shall be properly controlled. Correction of such errors shall be checked later during full size drawing inspection, member inspection, shop assembly inspection and other inspections.

1.2.5 AJIKAWA’s quality control program allows for coordination with control actions of the clients as outlined in the client’s specifications.

1.2.6 The clients shall have access to AJIKAWA drawings, specifications, records, purchase orders and other documents as required to accomplish all necessary control actions as set forth in the clients specifications.

1.2.7 Manager of each department in AJIKAWA shall oversee a training program for all the staff under his control.

1.2.8 Quality Management Representative shall audit Quality Program in order to insure proper quality control and improve the program.
1.3 CONTROL OF STANDARDS, DRAWINGS, SPECIFICATIONS, ETC.

1.3.1 Definition
The standards, drawings, specifications, etc. herein referred to include the following:
   a. Client’s specifications
   b. Drawings
   c. World standards
   d. Inspection reports
   e. Quality document

1.3.2 Control of documents
Project Dept. receives the client’s specifications. The original set of specifications is kept by Project Dept. and copies are delivered to the relating sections and departments. Project Dep. is responsible for the management of the client's specifications.

1.3.3 Control of drawings
Engineering Dept. is responsible for the management of drawings and required number of the copies are delivered to the relating sections and departments.

1.3.4 Control of world standards
Engineering Dept. manages the required world standards such as JIS, AWS, ASTM, BS, CSA, MIL, etc.

1.3.5 Inspection reports and other quality reports
QA Dept. is responsible for the management of all the inspection reports and other reports relating to quality.

1.3.6 The preservation period of documents
   a. The drawings are preserved by Engineering Dept. for five years from the final delivery of the contract products.
   b. The inspection reports and other quality documents are preserved by QA Dept. for five years from the final delivery of the contract products.
   c. The documents relating to nonconformance are preserved at least for five years from the final delivery of the contract products.
1.4 CHANGES OF SPECIFICATIONS AND DRAWINGS

1.4.1 The revised and additional drawings are delivered to the relating sections and departments with a transmittal note for acknowledgement of the receipt. The addendum of specifications is transmitted with a revision number and the contractual revisions are informed by "Information Note". These changes are reflected on the revised "Work Instruction".

1.4.2 When additional requirements or changes from clients are considered to give an adverse effect to quality or contract requirements, Project Dept., Engineering Dept., Production Technology Dept., Purchasing Dept., No.1 Factory of Chugoku Plant, Osaka Plant and QA Dept. will review these requirements and changes.

1.5 REVIEW OF CONTRACTS AND CONTRACT SCHEDULE
The Contract Review Meeting is convened by QA Dept. immediately after the receipt of contracts in participation of all the relating sections and departments for classification of contractual requirements.
At this meeting, both commercial and technical contract requirements including production quantity, delivery, drawings are classified and discussed by staff members of Project Dept., Engineering Dept., Production Technology Dept., Purchasing Dept., No.1 Factory of Chugoku Plant, Osaka Plant and QA Dept. The matters, which need classification by clients and proposals to clients, are also discussed.
Production schedule, delivery schedule, test schedule (including tower tests) and submittal schedule of drawings and other documents are also discussed to prepare the overall contract schedule.

1.6 QUALITY AUDIT
Quality audit shall be conducted annually to insure that all of the operations are performed in accordance with Quality Assurance Manual.
Some staffs in AJIKAWA are authorized by Quality Management Representative the auditing members.
1.7 CONTROL OF MACHINERY AND EQUIPMENT
The control of machinery and equipment is conducted for the purpose of maintaining and stabilizing product accuracy, as well as insuring safety operation. The managers of the departments engaged in the operation of machinery or equipment shall conduct the maintenance of machinery and equipment.

1.7.1 The personnel responsible for maintenance control
Engineering Department ....................... Dept. Manager
Production Technology Department ..... Dept. Manager
Osaka Plant ............................................. Plant Manager
Chugoku Plant......................................... No.1 Factory Manager

1.7.2 Routine maintenance
The routine maintenance is performed in terms of daily and periodical checkup.
The daily checkup is performed by operators of each machine in accordance with Daily Checkup Manual, which itemizes check points such as detection of mechanical disorder, and maintenance of mechanical precision. Each checkup result is reported to the section chief. The maintenance team takes proper maintenance action when a mechanical disorder is detected. The staffs in the department responsible for control of each machine or equipment perform the periodical checkup. Disorders detected during the periodical checkup are promptly repaired to restore proper mechanical operation.

1.7.3 Control of principal machinery and equipment

a. Heating furnace
   The performance is tested once every year by a thermometer.

b. Punching machine
   The daily checkup is performed prior to operation of the machine.

c. Drilling machine
   The daily checkup is performed prior to operation of the machine.
d. Shearing machine
   The daily checkup is performed prior to operation of the machine.

e. Numerically controlled (NC) machine
   
e.1. The annual checkup is performed to examine whether the NC machine is set horizontal to the ground and pitch lengths of the machine tools are precise.
   e.2. The mechanical precision of each machine is observed by keeping watch on the control chart every day.
   e.3. These manufacturers checkup the machinery unit manufactured by Kawasaki Heavy Ind. and the controlling unit manufactured by Fanuc, Ltd. once every three months.

f. Automatic drafting machine
   
f.1. The mechanical precision is checked up every six months in accordance with the master gauge.
   f.2. The manufacturer performs the checkup of the machine and the controlling unit once every three years.

1.7.4 "The maintenance guide for machinery and equipment" shall be referred to on the other particulars.

1.8 CONTROL OF MATERIAL TEST INSTRUMENTS
   The control is performed to maintain accuracy of the test instruments.

1.8.1 The periodical inspection of test instruments is performed annually by Nippon Kaiji Kyokai, an independent testing company, on Universal Testing Machine (AMSLER), Vicker’s Hardness Tester, and Impact Tester (CHARPY). The test certificates are shown at the testing room for manifestation.

1.8.2 Quality Assurance Manager is responsible for the control of material test instruments.
1.9 CONTROL OF MEASURING & TEST INSTRUMENTS AND TOOLS
The control is performed to maintain accuracy of measuring & test equipment and tools.

1.9.1 The designated personnel control the following tools and instruments:

a. Jigs
   Plant Manager
b. Check gauges
   (For punched & drilled holes)
   Plant Manager
c. Load cells
   Engineering Dept. Manager
d. Strain gauges
   Engineering Dept. Manager
e. Thickness gauges (galvanizing)
   QA Dept. Manager
f. Non-destructive equipment
   QA Dept. Manager
g. Steel tape
   QA Dept. Manager
h. Vernier calipers
   QA Dept. Manager
i. Micro meters
   QA Dept. Manager
j. Transit compass
   Plant Manager
k. Levels
   Plant Manager
l. Balances
   Plant Manager

1.9.2 The periodical inspection
Items a, g, h, i, j, k and l are annually inspected and the inspection results are recorded in the book. Item b, c, d, e and f are checked up prior to use.

1.9.3 The measuring control rule
The periodical inspection of measuring & testing instruments is performed in accordance with the Measuring Control Rule, which enumerates inspection methods and criteria conforming to JIS standard.

1.9.4 Inspection records
The inspection results of tools and instruments subjected to the annual inspection are recorded in the book and dates of inspection are written on the label affixed on each tool and instrument.
1.10 CONTROL OF FABRICATION JIGS

1.10.1 The Plant Manager controls the following fabrication jigs and media:
   a. Floppy disks for NC fabrication of steel angles.
   b. Steel tapes for manual fabrication of steel angles.
   c. Plastic templates for fabrication of gusset plates.

1.10.2 Inspection
   One piece of steel fabricated using these jigs is subject to inspection to insure accuracy of jigs.

1.11 CONTROL OF WELDING

1.11.1 The control of welding includes:
   a. The assignment of senior welding engineers.
   b. The assignment of welding engineers and welding operators.
   c. A question of qualification by welders for JIS Z 3801 and 3841.
   d. Education and guidance (on welding skill and subjects) for welders.

1.11.2 The number of qualified welding personnel.

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding engineers</td>
<td>26</td>
</tr>
<tr>
<td>Weld</td>
<td></td>
</tr>
<tr>
<td>Non-destructive inspection</td>
<td>10</td>
</tr>
<tr>
<td>Welders and Welding operators</td>
<td>50</td>
</tr>
<tr>
<td>Chugoku Plant</td>
<td></td>
</tr>
</tbody>
</table>

1.12 ACTION FOR NON-CONFORMANT

1.12.1 Conformance is determined based on the judgement standard in "Quality Control for tower manufacturing" (ref. annex 1) and "Non-conforming label" (ref. annex 2) is affixed on non-conformant products to segregate them from conformant products.
1.12.2 "Non-conformance report" (ref. annex 3) is issued by a section or a department responsible for such non-conformance and it is checked by Inspection Section before the responsible section or department proceeds with corrective action.

The corrective action is taken in accordance with "Corrective Action Notice" (ref. annex 4) which is released after approval of the manager of the responsible department.

Corrected products are subject to inspection by the staffs in Inspection Section. Quality Assurance Dept. records and keeps all the data on non-conformance and corrective action if they are called for by the contract.
SECTION 2. QUALITY CONTROL FOR TOWER MANUFACTURING

This section refers to the tower manufacturing practice and the dimensional tolerances.

2.1 QUALITY CONTROL FLOWCHART
2.2 APPLICABLE STANDARDS FOR QUALITY CONTROL

2.2.1 General technical standards
   a. JIS: Japanese Industrial Standard
   b. ASTM: American Society for Testing and Materials
   c. AWS: American Welding Society
   d. BS: British Standards Institution
   e. CSA: Canadian Standards Association
   f. MIL: Military Specifications and Standards
   g. ISO: International Organization for Standardization

2.2.2 Technical standards for domestic utilities

2.2.3 Quality Assurance Manual

2.3 PROCUREMENT OF MATERIALS

2.3.1 Steel material
   a. The types of steel provided for tower fabrication are as follows:
      Angle shapes (equal and unequal), pipes, plates, bars (round and flat),
      bolts & nuts and other shapes.
   b. Grades of steel materials
      Angle ..........JIS G 3101 "Rolled steel for general structure"
      Pipe ..........JIS G 3444 "Carbon steel tubes for general structural purposes"
      Plates..........JIS Z 3101 "Rolled steel for general structure"
      JIS G 3106 "Rolled steel for welded structure"
<table>
<thead>
<tr>
<th>JIS</th>
<th>Symbol</th>
<th>Chemical composition</th>
<th>%</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>Mn</td>
<td>Si</td>
</tr>
<tr>
<td>G3101</td>
<td>SS400</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>SS540</td>
<td>0.30 max</td>
<td>1.60 max</td>
<td>-</td>
</tr>
<tr>
<td>G3444</td>
<td>STK400</td>
<td>0.25 max</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>STK540</td>
<td>0.23 max</td>
<td>1.50 max</td>
<td>0.55 max</td>
</tr>
<tr>
<td>G3106</td>
<td>SM490A</td>
<td>0.20 max</td>
<td>1.50 max</td>
<td>0.55 max</td>
</tr>
<tr>
<td></td>
<td>SM490B</td>
<td>0.22 max</td>
<td>1.50 max</td>
<td>0.55 max</td>
</tr>
<tr>
<td></td>
<td>SM520B</td>
<td>0.18 max</td>
<td>1.50 max</td>
<td>0.55 max</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.20 max</td>
<td>1.50 max</td>
<td>0.55 max</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.20 max</td>
<td>1.50 max</td>
<td>0.55 max</td>
</tr>
</tbody>
</table>
Table 2. Tolerance

<table>
<thead>
<tr>
<th>Type</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle shapes</td>
<td>JIS G 3192 Dimensions, Mass and Permissible Variations of Hot Rolled Steel</td>
</tr>
<tr>
<td></td>
<td>Sections.</td>
</tr>
<tr>
<td>Pipes</td>
<td>JIS G 3444 Carbon Steel Tubes for General Structural Purposes.</td>
</tr>
<tr>
<td>Plates</td>
<td>JIS G 3193 Dimensions, Mass and Permissible Variations of Hot Rolled Steel</td>
</tr>
<tr>
<td></td>
<td>Plates, Sheets and Strip.</td>
</tr>
</tbody>
</table>

Table 3. Shape and Tolerance on Dimension of Angle Shape

<table>
<thead>
<tr>
<th>Item</th>
<th>Tolerance</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg length [A]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 50</td>
<td>± 1.5</td>
<td></td>
</tr>
<tr>
<td>50 or over to and excl.100</td>
<td>± 2.0</td>
<td></td>
</tr>
<tr>
<td>100 or over to and excl.200</td>
<td>± 3.0</td>
<td></td>
</tr>
<tr>
<td>200 or over</td>
<td>± 4.0</td>
<td></td>
</tr>
<tr>
<td>Leg length A or under 130 in depth</td>
<td>± 0.6</td>
<td></td>
</tr>
<tr>
<td>Under 6.3</td>
<td>± 0.7</td>
<td></td>
</tr>
<tr>
<td>6.3 or over to and excl.10</td>
<td>± 0.8</td>
<td></td>
</tr>
<tr>
<td>10 or over to and excl.16</td>
<td>± 0.8</td>
<td></td>
</tr>
<tr>
<td>Leg length A or 130 or over in depth</td>
<td>± 1.0</td>
<td></td>
</tr>
<tr>
<td>6.3 or over to and excl.10</td>
<td>± 1.0</td>
<td></td>
</tr>
<tr>
<td>10 or over to and excl.16</td>
<td>± 1.2</td>
<td></td>
</tr>
<tr>
<td>16 or over to and excl.25</td>
<td>± 1.5</td>
<td></td>
</tr>
<tr>
<td>25 or over</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg length A or 130 in depth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 6.3</td>
<td>± 0.8</td>
<td></td>
</tr>
<tr>
<td>6.3 or over to and excl.10</td>
<td>± 0.8</td>
<td></td>
</tr>
<tr>
<td>10 or over to and excl.16</td>
<td>± 1.0</td>
<td></td>
</tr>
<tr>
<td>16 or over to and excl.25</td>
<td>± 1.2</td>
<td></td>
</tr>
<tr>
<td>25 or over</td>
<td>± 1.5</td>
<td></td>
</tr>
<tr>
<td>Out-of-square</td>
<td>2.5% or under of width of leg length</td>
<td></td>
</tr>
<tr>
<td>Bend</td>
<td>0.30% or under of length</td>
<td>To be applied to bend such as sweep and camber.</td>
</tr>
</tbody>
</table>

Table 4. Tolerance on Outside Diameter of Pipe

<table>
<thead>
<tr>
<th>Class</th>
<th>Tolerance on outside diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>Under 50mm ± 0.5mm</td>
</tr>
<tr>
<td></td>
<td>50mm min. ± 1%</td>
</tr>
<tr>
<td>No. 2</td>
<td>Under 50mm ± 0.25mm</td>
</tr>
<tr>
<td></td>
<td>50mm min. ± 0.5%</td>
</tr>
</tbody>
</table>
### Table 5. Tolerance on Thickness of Pipe

<table>
<thead>
<tr>
<th>Class</th>
<th>Tolerance on thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>Under 4mm excl. + 0.6mm -0.5mm</td>
</tr>
<tr>
<td></td>
<td>4mm min. under 12mm excl. + 15% -12.5%</td>
</tr>
<tr>
<td></td>
<td>12mm min. + 15% -1.5mm</td>
</tr>
<tr>
<td>No. 2</td>
<td>Under 3mm excl. ± 0.3mm</td>
</tr>
<tr>
<td></td>
<td>3mm min. under 12mm excl. ± 10%</td>
</tr>
<tr>
<td></td>
<td>12mm min. + 10% -1.2mm</td>
</tr>
</tbody>
</table>

### Table 6. Tolerance on Length of Steel Plate and Sheet

<table>
<thead>
<tr>
<th>Length</th>
<th>Thickness</th>
<th>Tolerance A</th>
<th>Tolerance B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal cutting</td>
<td>Re-shearing or fine cutting</td>
<td></td>
</tr>
<tr>
<td>Under 6300, excl.</td>
<td>Under 6.00, excl.</td>
<td>+ 25</td>
<td>+ 5</td>
</tr>
<tr>
<td></td>
<td>6.00 or over</td>
<td>+ 25</td>
<td>+ 10</td>
</tr>
<tr>
<td>6300 or over</td>
<td>Under 6.00, excl.</td>
<td>+ 0.5 %</td>
<td>+ 10</td>
</tr>
<tr>
<td></td>
<td>6.00 or over</td>
<td>+ 0.5 %</td>
<td>+ 15</td>
</tr>
</tbody>
</table>

Remark: Tolerance B does not apply to that of 20 mm or over in width.
c. Suppliers list of structural steels
   NKK Corporation
   Sumitomo Metal Industries, Ltd.
   Kobe Steel, Ltd.
   Nippon Steel Corporation
   Topy Industries, Ltd.
   Kawasaki Steel Corporation
   Osaka Steel Co., Ltd.
   NKK Bars & Shapes Co., Ltd.
   Nakayama Steel Works, Ltd.

d. Bolts and Nuts
   Bolts and Nuts shall be in conformity to the standards of bolts and nuts for transmission line towers and of high tensile bolts and nuts for transmission line towers (Japan Steel Tower Association).

e. Welding consumables

   e.1. Covered arc electrodes
   e.2. CO₂ gas arc welding electrodes
   e.3. Submerged arc welding consumables

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>JIS</th>
<th>Product number</th>
<th>Diameter (mm)</th>
<th>Type</th>
<th>Position</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild steel</td>
<td>JIS Z 3211</td>
<td>B-14</td>
<td>3.2~4.0</td>
<td>D 4301</td>
<td>all</td>
<td>Kobe Steel, Ltd.</td>
</tr>
<tr>
<td></td>
<td>JIS Z 3211</td>
<td>LB-47</td>
<td>4.0~5.0</td>
<td>D 4316</td>
<td>all</td>
<td>&quot;</td>
</tr>
<tr>
<td>High tensile steel</td>
<td>JIS Z 3212</td>
<td>LB-52T</td>
<td>3.2~4.0</td>
<td>D 5016</td>
<td>all</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>JIS Z 3212</td>
<td>LB-52</td>
<td>4.0~6.0</td>
<td>D 5016</td>
<td>all</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
### e.2. CO₂ gas arc welding electrodes

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>JIS</th>
<th>Product number</th>
<th>Diameter (mm)</th>
<th>Position</th>
<th>Supplier</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild steel</td>
<td>JIS Z 3313</td>
<td>DW-Z100</td>
<td>1.2~1.6</td>
<td>H.F.</td>
<td>Kobe Steel, Ltd.</td>
<td>Flux</td>
</tr>
<tr>
<td></td>
<td>(YFW-C50DR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JIS Z 3312</td>
<td>MG50</td>
<td>1.2~1.6</td>
<td>H.F.V.</td>
<td>&quot;</td>
<td>Solid</td>
</tr>
<tr>
<td></td>
<td>(YGW-11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JIS Z 3312</td>
<td>MG50T</td>
<td>1.2~1.6</td>
<td>H.F.V.</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>(YGW-12)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>High tensile</td>
<td>JIS Z 3312</td>
<td>MG50</td>
<td>1.2~1.6</td>
<td>H.F.V.</td>
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<td>&quot;</td>
</tr>
<tr>
<td>steel</td>
<td>(YGW-11)</td>
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### e.3. Submerged arc welding consumables

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>JIS</th>
<th>Wire</th>
<th>Type</th>
<th>Diameter (mm)</th>
<th>Type of flux</th>
<th>Position</th>
<th>Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild steel</td>
<td>JIS Z 3311</td>
<td>US43</td>
<td>4.8</td>
<td></td>
<td>PFH-45</td>
<td>butt</td>
<td>Kobe Steel, Ltd.</td>
</tr>
<tr>
<td></td>
<td>(YSW-11)</td>
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<td></td>
</tr>
<tr>
<td>High tensile</td>
<td>&quot;</td>
<td>US43</td>
<td>4.8</td>
<td></td>
<td>PFH-65A</td>
<td>butt</td>
<td>&quot;</td>
</tr>
<tr>
<td>steel [50K]</td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### f. Zinc material

f-1. Zinc metal ..........JIS H 2107

f-2. Suppliers

- Sumitomo Metal Mining Co., Ltd.
- Nippon Mining Co., Ltd.
- Mitsui Mining & Smelting Co., Ltd.

### g. Suppliers of paint

1) Kansai Paint Co., Ltd.
2) Chuden Kogyo Co., Ltd.
3) Shinto Paints Co., Ltd.
4) Toa Paint Co., Ltd.
5) Chugoku Marine Paints, Ltd.
6) Nippon Oil & Fats Co., Ltd.
2.4 CONTROL OF MANUFACTURING PROCESS

2.4.1 Preparation of process chart
Production Plan Control Dept. prepares the process chart. Production Plan Control Dept. prepares the process charts of long term (3 months ahead) and of short term (1 month ahead), taking contract delivery, production capacity, and monthly operation plan into consideration. The process charts are issued on or around 25th day of every month and distributed to all relating sections and plants.

2.4.2 Control system
Joint meeting on production schedule is held bi-monthly attended by responsible personnel from all relating sections and plants. At the second bi-monthly meeting, the production schedule for the following month is reviewed on the item by item basis, referring to the process chart. Should any problem arise or be expected to arise in the production, the countermeasure is determined at the meeting. Business Control Dept. or Project Dept. takes prompt actions to inform the client in advance of possible delay of delivery. The first bi-monthly meeting is to make an intermediate review of the production process, and should there be any problem the attendants are reminded of special attention to the problem.
Production Plan Control Dept. makes daily check of production process and records daily progress in the process chart. The department issues an advance notice to all sections and plants concerned when any possible problem is anticipated.

2.4.3 Procedures to solve unexpected troubles in production process
In the events of unexpected troubles in the production process due to changes of specifications, external factors or in-plant problems, such a situation is immediately reported to Production Plan Control Dept. Where the problem will be discussed with the responsible section to find out prompt corrective actions or an emergency meeting will be held in the case of difficult situation. Business Control Dept. or Project Dept. notifies the circumstances to the client in order to seek their understanding in advance for possible delay of delivery, if necessary.
2.5 TOWER DESIGN

Engineering Dept. conducts design, shop detailing, preparation of technical documents, tower test and controls technical specifications, documents and books.

2.5.1 Manager of Engineering Dept. controls all of the above assignments.

2.5.2 The personnel on managing duty in Engineering Dept. participate in discussions to insure quality of design and shop detailing in terms of manufacturing efficiency, interchangeability and inspection facility.

2.5.3 Engineering Dept. shall contact clients when there are matters to clarify on their drawings or specifications.

2.5.4 All the drawings and technical documents shall not be changed after approved by clients, unless otherwise agreed upon.

2.5.5 Engineering Dept. consists of No.1, No.2 and No.3 Technical Sections.
The following flow charts represent the overall work done by each of these sections.

![Flow Chart]

**Design**

- Award of contract
- Work planning
- Assignment of staff
- Design conference with the client
- Preparation of the conference minutes
Shop Drawing

- Client’s specification
- Design drawings

Review

Calculation of material requirement

Issue of material requisition sheet

Drafting

Check

Drawing submittal

Client Approval

Full-size drawing

No

Yes

Inspection of full-size drawing

Piece-marking

Check

No

Yes

Determination of bolt length and issue of bolt requisition sheet

Check

No

Yes
2.6 FULL SIZE DRAFTING (LOFTING)
NC data and templates are prepared based on full size drawings.
Manager of Production Technology Dept. is responsible for the assignment.

2.6.1 Classification between computerized full size drafting and manual full size drafting are as follows:
Drafting by computer…………tower body and cross arms.
Manual full size drafting………special arms, ladders, hand rails, steps, landings and other accessories

2.6.2 Allowable dimensional tolerance for full size drawings:
Max. ±0.5 mm to the entire tower height

2.6.3 Scope of the inspection
Basic dimensions, member sizes, gauges, bolt diameters and the number of bolts, fitting dimensions of each hardware, dimensions of accessories, etc. are subject to inspection witnessed by Engineering Dept.
Inspection is carried out also on output data of the computerized full size drafting.

2.6.4 Action after the inspection
The full size drawings are modified in accordance with the inspection report and modified shop drawings, the full size drawings thus modified are inspected again by Engineering Dept.

2.6.5 Erasure of full size drawings
Full size drawings are erased upon completion of full size drafting.

2.6.6 Preparation of fabrication NC data (tapes) and templates
a. Computerized full size drafting system provides NC data and templates automatically, while the floor drafting provides tapes and templates manually.

b. Dimensional tolerance of tapes and templates:
Tapes ±0.5mm to the length of a single member, templates ±0.2mm to a single piece shall be accepted.
c. Inspection procedure
The tapes and templates prepared by the manual lofting are checked up with full size drawings and fabrication drawings, while NC data and templates prepared by the computer are checked up with output data.

d. Post inspection procedure
Erroneous NC data, tapes and templates are modified after inspection. The supervisor checks up NC data, tapes and templates modified by staffs.

e. Preservation period of NC data, tapes and templates
The NC data, tapes and templates are preserved until the tower erection at site and the final acceptance inspection is completed.

2.7 MATERIAL CONTROL
Materials are purchased in accordance with "Material Procurement Manual" and requirements of client's specifications. Purchasing Dept. Manager is responsible for material procurement.

2.7.1 Material acceptance
The purchased materials are delivered to the storage and controlled by Material Control Section.

a. Steel materials are purchased from the following steel mills.
Steel shapes of L150×l9 and smaller sizes
   NKK Bars & Shapes Co., Ltd., Osaka Steel Co., Ltd.
   and Topy Industries, Ltd.
Steel shapes of 175×l2 and larger sizes
   NKK Corporation, Nippon Steel Carp. and Topy Industries, Ltd.
Steel plates
   Sumitomo Metal Ind., Ltd., NKK Corporation
   and Nakayama Steel Works Ltd.

b. Acceptance of the purchases is controlled in accordance with "Material Purchase Control Manual - inspection criteria for material acceptance and color cord identity table on different grades of steel" and "Material Purchasing Specifications".
c. Material Control Section staffs in accordance with the following criteria carry out the acceptance inspection;

   c.1. Visual and dimensional inspections
   Each material lot is subject to sampling for visual inspection on straightness and being free from scratches and rust.
   The dimensional check is carried out on the leg length of angles and thickness of plates to insure that materials are within tolerances specified in JIS or other applicable standards.

   c.2. Verification of charge numbers
   The charge number of each bundle of steel is checked with reference to mill certificates, die stamps and metal tags on steel.

   c.3. Steel plates
   At each time of receiving, plates of grades other than SS-400 are checked up with mill certificates and marked by white paint.
   The plates are stored by size.

2.7.2 Material storage

   a. Rolled steel is temporarily stocked in warehouses designated by steel mills and the fabrication plant receives required amount of steel.

   b. The delivery of steel is based on FIFO (first-in, first-out).

   c. The accepted steel shapes are painted in a designated color at the cross section of steel end as shown and the table listed below. Charge number steel grade and length are marked in white paint at the end of each piece of steel to prevent mixture of steel grades.
   Required amount of steel is delivered to the fabrication shop after it is most efficiently assorted with reference to the fabrication list. Each piece of steel is used so that each leftover piece shows material grade and charge number.
### Material Identification by Color Cords

<table>
<thead>
<tr>
<th>Position</th>
<th>Angle</th>
<th>Tube</th>
<th>Plate</th>
<th>Shaped steel</th>
<th>Round bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spec.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>SS</td>
<td>400</td>
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<td>red ×1</td>
<td>red ×1</td>
<td>red ×1</td>
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<tr>
<td></td>
<td>490</td>
<td>green ×1</td>
<td>blue ×1</td>
<td>blue ×1</td>
<td>green ×1</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>400A</td>
<td>White &amp; red ×1</td>
<td>red ×1</td>
<td>red ×1</td>
<td>red ×1</td>
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<tr>
<td></td>
<td>B</td>
<td>red ×2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>red ×3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>490A</td>
<td>yellow ×1</td>
<td>yellow ×1</td>
<td>red ×1</td>
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<td></td>
<td>B</td>
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<td>yellow ×1</td>
<td>red ×3</td>
<td>red ×3</td>
</tr>
<tr>
<td></td>
<td>C</td>
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<td>orange ×1</td>
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<td></td>
<td>C</td>
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<td>SMA</td>
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<td>white ×1</td>
<td>red ×1</td>
<td>red ×1</td>
</tr>
<tr>
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<td>red ×3</td>
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</tr>
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<td></td>
<td></td>
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<td></td>
<td>G65</td>
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<td>blue ×1</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td>green ×1</td>
<td>green ×1</td>
<td>green ×1</td>
<td>green ×1</td>
</tr>
<tr>
<td>STK</td>
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<td>yellow ×1</td>
<td>yellow ×3</td>
<td>yellow ×3</td>
</tr>
<tr>
<td></td>
<td>540</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPA-H</td>
<td>HY</td>
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<td>yellow ×1</td>
<td>yellow ×3</td>
<td>yellow ×3</td>
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<td>pink ×1</td>
<td>pink ×1</td>
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</tr>
<tr>
<td></td>
<td>400N</td>
<td>black ×1</td>
<td>black ×1</td>
<td>black ×1</td>
<td>black ×1</td>
</tr>
</tbody>
</table>

#### 2.7.3 Care for storage

The following cares shall be taken to maintain quality of the supplies:

a. The supplies shall be stored in good and proper order.

b. The supplies, which are subject to moisture, are stored using raised floors, cross ties or damp-proof agent.
c. Proper stands, coverings, ties, etc. are used to prevent supplies from stain or damage.

d. Care shall be taken so that stored material may not be stolen or deteriorated. Deteriorated material shall be marked in red paint and kept separately.

e. The utmost care shall be taken of dangerous supplies, which are explosive and inflammable in observance of fire and other relating regulations.

f. The storehouse shall be carefully maintained and be repaired immediately should any damage be found. The periodic checkup shall be made against leak on the roof and floor, which may jeopardize proper maintenance of the supplies.

2.7.4 Delivery of materials
Materials are delivered by means of Delivery Note (ref annex 5). "Steel Material Requisition Sheet" prepared based on "Fabrication List" may be used as a substitute for Delivery Note.

2.7.5 Non-conformant materials

a. Materials, which do not conform to "Material Acceptance Inspection Criteria" are rejected and are returned to suppliers.

b. Scrap and deteriorated materials
Steel shapes shorter than one meter and steel pipes shorter than two meters are scrapped. Deteriorated steel materials due to stain, damage, deformation, corrosion, etc. are scrapped every six months.

2.7.6 Inspection report
Quality Assurance Dept. prepares the reports.
2.8 CONTROL OF SUBCONTRACTED WORK

2.8.1 Bolts and nuts

a. Bolts and nuts are purchased from the following suppliers:
   Artes Inc.
   ISK Co., Ltd.
   Hankyu Iron Works Co., Ltd.

b. Receiving inspection
   The receiving inspection for bolts and nuts is performed in accordance with the standard stipulated in the contract specifications. The corrective action for non-conformant products is referred to the standard stipulated in the contract specifications.

2.8.2 Sheared plates

a. Steel sheets are delivered to shearing companies listed below who are affiliated with blast furnace steel mills;
   Yamato Shearing Co., Ltd.
   Kyowa Tokushu-Kou Co., Ltd.
   Chugoku Shearing Co., Ltd.

b. Shearing of steel sheets
   Steel sheets are sheared after checkup of steel grades, sizes and charge numbers and shearing instruction sheets.

c. Marking
   Designated markings are stamped on sheared plates.

d. Receiving inspection
   Receiving inspection is performed in accordance with "Purchasing Manual" and "Quality Control Standard Manual for Steel Plates".

e. Preservation of receiving data
   The mill certificates of steel sheets and relating documents are preserved for five years.
2.9  SHOP FABRICATION

2.9.1  Marking-off

a. Marking-off procedures:

a.1. Gusset plates
   Gusset plates are marked-off and then cut to the designated shapes using templates. Then, drilling or punching positions are marked on shaped plates by a center punch through a film template placed on them, followed by symbols of bolt diameters, bending positions and angles being marked.

a.2. Steel shapes
   Steel shapes cut to specified length are marked with symbols, such as hole gauges, pitch lines, hole diameters clipping, bending, aperture, squeeze and heeling, in accordance with NC data or templates. Members to be drilled are painted with white powder, and then a marking-off pin with reference to NC data or templates marks drilling gauges and pitches lines.

a.3. Allowable tolerance of marking-off dimensions is ±0.5mm.

a.4. Inspection procedure
   The supervising staff for marking-off inspects marking-off, using film templates or steel tapes.

a.5. Corrective action
   Should any members be rejected, correction marks are put on them for immediate rework. Corrected members are subject to re-inspection.
2.9.2 Cutting

a. Cutting procedure

a-1. Gusset plats
Gusset plates of less than 12mm in thickness are sheared and those of no less than 12mm are cut by an automatic gas cutter. A manual gas cutter may be used in an unavoidable case and the cut surface is finished with a grinder.

a.2. Steel shapes
The angle cutter shears steel shapes less than 12mm in thickness. The sawing machine is used for those of greater thickness and they are chamfered with a file.

b. Allowable tolerance of cut length
The tolerance is –0mm to +2mm for both plates and shapes.

c. Inspection procedure
The supervising staff of cutting checks up plates and shapes in accordance with templates or steel tapes.

d. Corrective action
The material exceeding the tolerance is re-cut to the proper dimension. The rejected material due to shorter cutting is marked "non-conforming" and is replaced with the one of proper length.
2.9.3 Punching & drilling

a. Punching & drilling procedure

a.1. Gusset plates
Steel plates of less than 12mm in thickness are punched. They are also punched by copy punching devices, which do not require prior marking-off. Those of 12mm or greater thickness are drilled and drilled holes are chamfered.

a.2. Shapes
Shapes of less than 12mm in thickness are punched. Those of 12mm or greater thickness are drilled by the radial drilling machine and the drilled holes are chamfered.

b. Allowable tolerance of drilling
±1mm

c. Inspection procedures

c.1. Gusset plates
Identical plates are piled up for inspection of bolt holes and their locations, using inspection sticks of different diameters. The template is used to inspect a single plate.

c.2. Shapes
Identical shapes are piled up for inspection, placing one checked with a steel tape on the top of them and the same inspection procedure as for plates is applied. For those, which are difficult to pile up, inspection is performed on individual member with steel tapes.

d. Treatment of inspection result
Materials drilled or punched in excess of designated diameters or with bolt holes drifting from gauge lines or erroneous pitches are marked "non-conformant" and stored separately for replacement.
Those of missing and incomplete bolt holes are subject to additional drilling or punching and re-inspection.

2.9.4 Bending

a. Bending procedure

a.1. Gusset plates
Gusset plates are subject to cold bending by the hydraulic press in most cases.

a.2. Steel angles
Steel angles, which require simple bending, are cold bent to a designated angle by the hydraulic press considering a bending angle and steel grade.
Other materials are hot bent to a designated angle by the hydraulic press or by a hammer, after they are heated to approx. 800°C~900°C.
The thermal effect to those materials shall be fully taken into consideration.

b. Allowable tolerance of the bending angle is ±17’ (200:1).

c. Inspection procedure
Materials subjected to bending are checked on bending-angle using bending patterns, particularly those subjected to hot forming are required to be checked after they have been fully cooled.
Bent materials are checked up on cracks and scars.
Flatness of legs of steel angles is inspected on the angle plate. One out of each lot of bent materials is randomly selected for inspection for small and medium sizes. Then it is used as a model to check up flatness of the rest, placing it on top of them.

d. Corrective action
Faulty bending is modified to the specific angle. If the modification is not practicable, such materials are marked "non-conformant" and placed at deficient material storage.
New material is then prepared for replacement.

2.9.5 Welding
The welding operation is controlled as follows:

a. Welding rods
The following types of welding rods are used for arc welding.

a.1. The coated electrode for mild steel ..... JIS Z 3211

a.2. The coated electrode for high tensile strength steel ..... JIS Z3212
Prior to use, the low hydrogen electrode is dried for approx. one hour at the temperature between 300°C and 350°C in the electrode oven.
Special care is required for proper handling and storage.

b. Welding machines
The following welding machines are used.

b.1. A. C. arc welding machine (300 - 500A) as specified in JIS C 9301.
b.2. CO₂ arc welding machine (300 - 500A) and submerged arc welding machine.

c. Welders
Qualified persons who have certificates of welding faculty of JIS Z 3801 A-2F or higher grade perform the welding work.

d. Welding operation
Prior to welding, a proper groove shape is selected for complete penetration and padding, depending on various joint shapes of welding members. Gas cutting or machine finish prepares the groove shape.
Welding areas are cleaned with a wire brush to remove stain, dust and rust which give adverse effects on weldment.
Various types of jigs are used for welding operation so that weldment will not cause any structural deformation and that residual stress may be minimized, as well as operators will be able to work at as much downward position as possible.
For large-sized XP material, the symmetrical welding or spot welding may be applied to minimize deformation, shrinkage and residual stress due to welding.

For butt welding, the first layer is prepared free from poor penetration by arc air gauging before the second layer is welded.

For welding of angles larger than L150×l2, they are pre-heated at approx. 100°C～150°C with gas flame in order to prevent bead cracks and cold cracks.

e. Allowable dimensional tolerance after welding
The dimensional tolerance against deformation due to welding is limited to 1mm per 1m length.

f. Inspection procedure
The welding inspection consists of operational inspection and acceptance inspections.
The operational inspection is performed to check welding materials, welding preparation, welding process and post welding treatment, while the acceptance inspection is performed to inspect the welding workmanship.

f.1. Operational inspection
Prior to welding operation, welders carefully check groove angles, root opening, surface of joints (rust, grease and other stains) and backing strip.
Welders carefully check on fusion, mixture of slugs, cracks, beads and undercuts of each layer during welding operation, since defects on weldment will reduce the structural strength.
If welders detect any deficiency during welding operation, such deficiency is subject to modification immediately.

f.2. Acceptance inspection
All the welded materials are visually checked on bead appearance, undercut, overlap, leg length of fillet weld, cracks and welding deformation.
The welded materials are subject to random sampling inspection for color check and mechanical tests (tensile, bending, hardness and
impact). Also, X-ray inspection, ultrasonic detection, magnetic detection or microstructure test may be carried out if required.

f.3. Corrective action
When defects on weldment are detected at the acceptance inspection, they are corrected as follows.

1. Cracks and slag intrusions are ground by arc air gauging before re-welding.

2. Undercuts and overlaps are chiseled and then reinforced by welding.

3. Roller press or heat treatment corrects welding deformations.

f.4. The allowable tolerances and inspection procedures for each inspection item are as listed below.
Tables for Inspection Items for Welds and Allowable Tolerances

The allowable tolerances and the inspection procedures for each inspection item are as listed below:

Table 1. Welded joints

<table>
<thead>
<tr>
<th>Item</th>
<th>Welding members</th>
<th>Allowable tolerance</th>
<th>Inspection method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offset</td>
<td>t 15mm ; e &lt; 1.5mm</td>
<td>Scale and Thickness gauge</td>
<td></td>
</tr>
<tr>
<td>Root opening</td>
<td>Manual welding</td>
<td>0 4 mm</td>
<td>Thickness gauge</td>
</tr>
<tr>
<td></td>
<td>CO2 gas arc welding or automatic welding</td>
<td>0 3 mm</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Detail of welds</td>
<td>Allowable dimensional tolerance</td>
<td>Inspection procedure</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Bead surface</td>
<td><img src="image" alt="Diagram" /></td>
<td>Shall not spoil appearance remarkably</td>
<td>Visual inspection</td>
</tr>
<tr>
<td>Leg length Throat</td>
<td><img src="image" alt="Diagram" /></td>
<td>0 □ L – S □ +5.0(mm) However, -0.1S is allowable as tolerance for welding length of less than 10%.</td>
<td>Leg gauge</td>
</tr>
<tr>
<td></td>
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<td>S / □ 2 □ a However, -0.07S is allowable as tolerance for welding length of less than 10%.</td>
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<tr>
<td>Reinforcement of fillet weld</td>
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</tr>
<tr>
<td>Slug &amp; spatter</td>
<td><img src="image" alt="Diagram" /></td>
<td>Shall be removed.</td>
<td>Visual inspection</td>
</tr>
</tbody>
</table>
2.10 GALVANIZING
(Licensed by JIS, License No. 577102)

2.10.1 The list of zinc metal suppliers:
Sumitomo Metal Mining Co., Ltd.
Nippon Mining Co., Ltd.
Mitsui Mining and Smelting Co., Ltd.
The zinc metal is checked with reference to the attached certificate of analysis at the receiving inspection, and is kept at the storehouse.

2.10.2 Galvanizing process:
The galvanizing process consists of the following steps:

- **Degreasing**
  Oil, grease and other organic matters attached to materials are removed by immersing them in the solution of alkali cleaner and caustic soda of 2% ~ 5% concentration mixed with surface active agent at the solvent temperature of 80°C. After degreasing, materials are fully rinsed in water to remove dirty solvent adhered to them.
b. Pickling
Materials are immersed in approx. 60°C acid solution of 9% ~ 25% concentration with pickling inhibitor to remove scale and rust adhered to them. After pickling, materials are fully rinsed in water to remove sulfuric acid.

c. Fluxing
Materials are immersed in approx. 40°C solution of zinc ammonium chloride of no less than 32% concentration with a surface-active agent. Materials are then withdrawn from the solution to remove drippings, and water contents of flux on materials are dried.

d. Galvanizing
After completion of the required pretreatment, materials are immersed in the molten zinc bath for the designated time and excess zinc is removed from the steel surface.

e. Post treatment
After excess zinc is removed from the steel surface, galvanized materials are quenched to solidify the zinc layer.
Then, galvanized materials are subjected to the finishing touch to remove projections and other defects on the steel surface, which may cause peeling off of the zinc film due to impact. The finished materials are visually inspected and delivered to the sorting process.

2.10.3 Inspection

a. Visual inspection
The appearance is checked to detect the following harmful defects by visual and hand feeling inspections.

a.1. Non-galvanizing
The defective surface of the materials is exposed locally.

a.2. Dull grey coating
The galvanized surface on affected area is lusterless or grey colored and, in the worst, black grey colored.
a.3. Zinc drips
   Excess zinc adhered to the galvanized surface.

a.4. Blister and seam
   Uneven galvanizing due to deficiency of rolled steel which is uncontrollable in the galvanizing process.

a.5. Ash
   The surface covered with zinc oxide or heavy flux residue.

a.6. Granulated dross
   The galvanized surface is granulated and called "dross coating" in the worst situation.

a.7. Scars
   The galvanized surface scratched due to contact with galvanizing tools.

a.8. Defective steel material
   Non-conformant galvanizing due to material defects such as blisters, seams, etc.

b. Quality inspection
   The weight of coating test and the uniformity test are performed in accordance with JIS H 0401 "Methods of test for hot dip galvanized coatings". The test results are evaluated by the criteria specified in JIS H 8641 "Hot dip galvanizing" and clause 2.6.7, Galvanizing tests of JEC127 "Standards of design for transmission towers". All the tests can be performed in accordance with ASTM or BS standard if required by clients.

2:10.4 Treatment of inspection results

a. The standards of acceptance for visual inspections are as follows;

   a.1. Non-galvanizing
       Rejected
a.2. Dull grey coating
Local burns are accepted after finishing touch, if such areas are very limited.

a.3. Zinc drips
Minor drips are accepted after finishing touch.

a.4. Ash
Accepted after finishing touch.

a.5. Granulated dross
Accepted after finishing touch.

a.6. Scars
Slight scars are accepted after finishing touch.

b. Treatment of rejected materials

b.1. Defective galvanizing
All of such materials are re-galvanized.

b.2. Defective steel materials
All of such materials are replaced.

b.3. Galvanized materials rejected during quality inspection;
If galvanized materials are rejected in any one of tests and the other test results are satisfactory, the same number of the additional samples are prepared to repeat the test.
If all of the new samples are accepted after retest, these galvanized materials are finally accepted.
However, if any one of the samples fails in the retest, two times as many samples are provided for another test.
Should any one of the samples fail in the third test, all of the rejected materials are subject to re-galvanizing. The repeat of retest is allowed for two times only.
2.11 SORTING, PACKING AND DELIVERY

This clause covers the procedures after galvanizing to ex-factory of the products. The manager of Quality Assurance Dept. and Project Dept. will insure, in coordination with Product Section that all the working processes are followed in accordance with client's specifications. When the client's sorting and packing conditions do not conform to our procedures, such non-conformant conditions may be informed to clients to have them approved by clients.

Manager of No.1 Factory in Chugoku Plant is responsible for the packing & delivery work.

2.11.1 Straightening of galvanized steels

a. Procedure of straightening

Thirty-ton friction press is used to straighten members up to the length of 10 meters and fifty-ton friction press is used for those of 10 meters to 15 meters in length.

For members other than the above, 150-ton hydraulic press may be used.

b. Allowable tolerance for the straightened length

1/1,000 to entire length

c. Inspection procedure

Visual inspection

d. Treatment of inspection results

The deformed members are corrected by straightening them as specified above, members impracticable to be straightened or determined as harmful if they are straightened, shall be re-fabricated.

2.11.2 Product inspection

At the time of preliminary assortment, each member is assured of correct marking and appearance. Then, the members are bundled by like members and some by the bundles are put together for larger bundles. The bundling lists are prepared to check the member of bundles.
2.11.3 Corrective action
Should any erroneous member marking be detected, correction is made immediately. Inconsistency in the number of members is checked based on fabrication lists and additional members are fabricated in case of shortage.

2.11.4 Packing

a. Angles

a.1. Members exceeding 600mm in length shall be bundled and shorter members shall be packed in wooden cases.

a.2. The steel strap of 0.9mm or more in thickness and 19mm or more in width is fastened at both ends of the bundle by the automatic bundling machine.

a.3. If members are 2.5m or less in length, bundles are sub-bundled with galvanized steel wire to prevent material damage during transportation.

b. Gusset plates

b.1. Plates shall be packed in the wooden case and/or tied on the pallet.

b.2. Before securing the lid to the wooden case, wood fill material is used to prevent shifting of steels.

b.3. For the palletized packing, No.10 galvanized wire is used to fasten plates to the pallet. The wire is applied at least at two locations.

c. Bolts and nuts

Bolts, nuts and washers are packed in the wooden case or the small drum. They are sub-packed in cloth or chemical bags by size, and then packed into the wooden case or the drum.
d. Other items.
The best practicable packing method will be applied by item, including crating, skid, bare, etc.

e. Maximum weight and length of the package
The weight of one package does not exceed 2,000 kg.
The member length is less than 10 meters.

f. Color code
If necessary, the color code is applied to steel materials by tower type and destination.

g. Marking

g.1. Bundles and pallets
After the completion of packing, the cloth tag is attached to the both ends of each bundle. As for the palletized materials, two tags are attached to the uppermost members.

g.2. Wooden cases
Shipping marks are stenciled on both sides of each case prior to packing. After packing, weight and package numbers are stenciled on the case of weather resistant black ink.

h. Care for members finished by dull grey treatment
While bundling the members finished by dull grey treatment, buffers are placed between members and the members are bundled with galvanized steel wires covered by vinyl etc. or put on buffers to prevent material damage during transportation.

2.12 SHOP ASSEMBLY
Shop assembly inspection is performed in accordance with client's specifications to certify and assure quality of fabrication. "Quality Control Flow Chart" and "Quality Control Table of Manufacturing Process" are referred to for shop assembly work.
2.12.1 Shop assembly procedure
Tower members are assorted by piece marks and sections before towers are assembly. Towers are assembled horizontally on the ground. Tower bodies above cross arms are assembled on four faces and leg portions are assembled on two or three faces only. Crane cars are used to hoist framed members.

2.12.2 Inspection

a. Allowable tolerance
   Width ±3mm
   Height (panel to panel) ±3mm

b. Scope of inspection

b.1. Measurement of basic dimensions
   Tower height, base width, length between panels, arm length, member sizes, diameter and number of bolt holes and size and pitch of holes for tower fittings are inspected.

b.2. Workmanship of assembled towers
   Alignment of tower and tower members freedom from torsion or bending and ease of assembly are checked.

b.3. Fabrication workmanship
   Cutting, punching, drilling, heeling, clipping, bending, welding, gauge, pitch, missing and drifting of holes, member shortage, material deficiency, etc. are inspected with reference to drawings.

c. The section in charge of factory inspection
The shop assembly inspection staff members of each shop performs detailed checkup on towers during progress of shop assembly and every correction or re-fabrication required is recorded in "Re-fabrication List" to deliver than to the relating sections.
Q. A. Dept. performs the final inspection after towers are shop-assembled and discuss about inspection result with Engineering Dept. if required.
d. Corrective action
   All non-conformant members are completely corrected or replaced in accordance with instructions of "Re-fabrication List", and re-inspected by Inspection Section.

2.13 TOWER TEST
   The tower test is performed in accordance with the contract specifications.

   a. The department in charge of the tower test
      Engineering Dept. supervises the tower test. Inspection Section along with Project Dept. assists Engineering Dept. during testing towers.

   b. The operation of the tower test
      The overall operation of the tower test takes place as outlined in the following flow chart:

   c. Witness of tower tests
      Clients, consultants, or third party inspectors have access to the test site to witness tests.

   d. Tower test reports
      Tower test reports are prepared by Engineering Dept.
2.14 INSPECTION

Quality control for tower manufacturing is performed in accordance with "Quality Control Flow Chart" in Section 2.1.

The flow chart shows the relationship between quality control by shop workers and quality assurance by Quality Assurance Department.

2.14.1 Inspection items

a. Material inspection
b. Full size drawing inspection
c. Welding inspection
d. Shop assembly inspection
e. Galvanizing inspection
f. Member inspection
g. Packing inspection

2.14.2 Inspection criteria

a. Material inspection

   a.1. Shapes and plates
       Tests are performed periodically in accordance with JIS standard.

   a.2. Bolts and nuts
       Witness inspections are performed in accordance with applicable standards at acceptance of bolts and nuts.

b. Full size drawing inspection
   Basic dimensions member sizes, gauges, bolt diameters, number of bolts, fittings, etc. are checked.

c. Welding inspection
   Inspection is performed on appearance of welded members, measurement of leg length and throat, undercut, overlap, blow hole, slag inclusion and crack.
   Acceptance inspection is performed by QA Dept. on each welded member after completion of finishing of welds, based upon the following table:
d. Shop assembly inspection
   Please refer to Section 2-12.

e. Galvanizing inspection
   e.1. Appearance inspection
       Galvanized members are subject to visual and hand feeling
       inspection.
   e.2. Quality inspection
       Tests are performed on adhesion, weight of coating, uniformity and
       thickness of coating for each galvanizing lot.

f. Member inspection
   Inspection Section staff member inspects individual members with steel
   tapes and templates.

g. Packing inspection
   Packing size and appearance, piece marks, quantity, color cords, shipping
   marks, etc. are checked in accordance with "Packing Inspection Criteria"
   and packing lists.
<table>
<thead>
<tr>
<th>Item</th>
<th>Details of welds</th>
<th>Allowable dimensional tolerance</th>
<th>Inspection procedure</th>
<th>Treatment after inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bead surface</td>
<td><img src="image" alt="Bead surface" /></td>
<td>Shall not spoil appearance remarkably</td>
<td>Visual inspection</td>
<td>Shall be finished by grinder</td>
</tr>
</tbody>
</table>
| Leg length and throat of fillet welding | ![Leg length and throat](image) | $0 \leq L - S \leq +5.0$ (mm) However, $-0.1S$ is allowable as tolerance for welding length of less than 10%.
|                                  |                   | $S / \sqrt{2} \leq a$
|                                  |                   | However, $-0.07S$ is allowable as tolerance for welding length of less than 10%.
|                                  |                   | Thickness gauge
|                                  |                   | • Shall be re-welded for short leg length, and
|                                  |                   | • Shall be finished by grinding for long leg length.
|                                  |                   | • Shall be re-welded for short throat, and
|                                  |                   | • Shall be finished by grinding for long leg throat. |
| Reinforcement of fillet welding  | ![Reinforcement of fillet welding](image) | $+ (0.1S + 1mm)$ - 0
|                                  |                   | However, $-0.07S$ is allowable as tolerance for welding length of less than 10%.
|                                  |                   | Thickness gauge
<p>|                                  |                   | Excessive extra padding shall be finished by grinder. |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Details of welds</th>
<th>Allowable dimensional tolerance</th>
<th>Inspection procedure</th>
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</tr>
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<tbody>
<tr>
<td>Undercut</td>
<td><img src="image" alt="Diagram" /></td>
<td>“a” shall not be harmful.</td>
<td>Visual inspection</td>
<td>Shall be repaired with electrode of shall diameter.</td>
</tr>
<tr>
<td>Overlap</td>
<td><img src="image" alt="Diagram" /></td>
<td>“b” shall tot be excessive.</td>
<td>Visual inspection</td>
<td>Shall be finished by grinder.</td>
</tr>
<tr>
<td>Pit</td>
<td><img src="image" alt="Diagram" /></td>
<td>Harmful pits shall not be allowable.</td>
<td></td>
<td>Shall be re-welded after gauging.</td>
</tr>
<tr>
<td>Crack</td>
<td><img src="image" alt="Diagram" /></td>
<td>Shall be repaired completely.</td>
<td>Visual inspection and penetration inspection</td>
<td>Shall be re-welded after gauging more then 50mm from the both ends of crack.</td>
</tr>
<tr>
<td>Slag and spatter</td>
<td></td>
<td>Shall be removed</td>
<td>Visual inspection</td>
<td>Shall be removed by hammer, grinder, chipper, wire-brush, etc.</td>
</tr>
</tbody>
</table>
2.14.3 Corrective action
Non-conformant products are treated as specified in Section 1.12.

2.14.4 Approval
The inspection and test plan is submitted to the client for approval when it is required in the contract specifications.
<table>
<thead>
<tr>
<th>Work process</th>
<th>Operational description</th>
<th>Description of the control</th>
<th>Control methods and procedures</th>
<th>Corrective action</th>
<th>Controller</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Material acceptance</td>
<td>Material check</td>
<td>Rolling mills Material grades Charge numbers Material, Appearance (shapes &amp; dimensions) Quantity</td>
<td>“Material Inspection Standard” No excessive bend, twist, rust, damage</td>
<td>Whole lot -ditto- -ditto-</td>
<td>Visual inspection</td>
<td>Non-conformant materials are returned to suppliers.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Material grades and charge numbers are stated in delivery notes</td>
</tr>
<tr>
<td>(2) Cutting</td>
<td>Automatic gas cutting Band saw Grinding Shearing</td>
<td>Cut length Cut angle Texture of cross section Cut quantity</td>
<td>0 ≤ +2mm</td>
<td>Sampling 1 piece for each piece mark -ditto- -ditto-</td>
<td>Whole lot</td>
<td>Steel ruler, Square ruler, Templates, Visual inspection, Texture sample</td>
</tr>
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<td></td>
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<td></td>
<td>Record non-conformance on fabrication lists</td>
</tr>
<tr>
<td>(3) Marking-off</td>
<td>Marking-off on angles and plates</td>
<td>Fabrication instruction marks (positions and diameters of holes, clipping, heeling, fixing positions of plates)</td>
<td>± 0.5mm Thickness of marking line; 0.3mm or less</td>
<td>Sampling 1 piece for every piece mark</td>
<td>Whole lot</td>
<td>Templates, Steel rulers, Steel tape measure, Carpenter’s square</td>
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<td></td>
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<td></td>
<td>Fabrication lists, Drawings, NC data lists</td>
</tr>
<tr>
<td>(4) Die-stamping</td>
<td>Press stamping and manual stamping</td>
<td>Piece marks and depth of stamping</td>
<td>Thickness; 1<del>2mm Depth; 0.5</del>1mm</td>
<td>Whole lot</td>
<td>Visual inspection</td>
<td>Re-stamping</td>
</tr>
<tr>
<td>(5) Punching &amp; Drilling</td>
<td>Punching and drilling</td>
<td>Diameter and number of holes Pitch and gauge</td>
<td>Diameter; 0 ~ +0.5mm Pitch and gauge; ± 1mm</td>
<td>Sampling 1 piece for each piece mark</td>
<td>Steel tape measure, Diameter gauge, Templates, Vernier calipers</td>
<td>Fabrication lists</td>
</tr>
<tr>
<td>(6) Clipping</td>
<td>Shear clipping Gus clipping</td>
<td>Cutting precision Cutting precision</td>
<td>± 2mm ± 2mm( ∩ 100s)</td>
<td>Sampling 1 piece for each piece mark</td>
<td>Carpenter’s square Fabrication lists</td>
<td>Re-clipping or re-fabrication</td>
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<td>Clipping standard</td>
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<td>Work process</td>
<td>Operational description</td>
<td>Description of the control</td>
<td>Control methods and procedures</td>
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<tr>
<td>(7) Heeling</td>
<td>Plane heeling</td>
<td>Heeling precision</td>
<td>Whole lot Heeling gauge</td>
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<td></td>
<td>Round heeling</td>
<td>Heeling precision</td>
<td>Fabrication lists</td>
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<td></td>
<td></td>
<td>Width; +1～+3mm</td>
<td>Re-heeling or re-fabrication</td>
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<td>Radius; +1～+3mm</td>
<td>Manufacturing Sect.</td>
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<tr>
<td>(8) Bending</td>
<td>Press bending</td>
<td>Heating temperature</td>
<td>2 pcs per day Temperature</td>
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<td></td>
<td>Board bending</td>
<td>Bending angle and position</td>
<td>Angle; 800℃~900℃</td>
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<tr>
<td></td>
<td>Cut and bend</td>
<td>Appearance</td>
<td>No crack</td>
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<tr>
<td>(9) Assembly</td>
<td>Assembling of welding</td>
<td>Position; 2mm Angle;</td>
<td>Whole lot Gap gauge,</td>
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<td></td>
<td>parts</td>
<td>1 1 Gap(e); t 15mm,</td>
<td>Templates</td>
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<td>e 1mm t &gt; 15mm, e 2mm</td>
<td>Inspection drawing</td>
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<tr>
<td>(10) Welding</td>
<td>Covered arc welding</td>
<td>Welding material,</td>
<td>Whole lot Thermometer in</td>
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<td></td>
<td>Semi-auto welding</td>
<td>Welding conditions,</td>
<td>dryer, Current/voltage</td>
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<td>Automatic welding</td>
<td>Welding method,</td>
<td>meter, Leg gauge,</td>
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<td></td>
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<td>Welding workmanship</td>
<td>PT, VT, UT, RT</td>
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<td></td>
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<td>“Tower manufacturing</td>
<td>Welding universal gauge</td>
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<td>standard”</td>
<td>Check sheet</td>
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<td>(11) Stress</td>
<td>Stress relief of</td>
<td>Member bending</td>
<td>Whole lot String, Steel ruler,</td>
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<td>weldment</td>
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<td>Temperature choke,</td>
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<td>No, more than L/1000</td>
<td>Thermometer,</td>
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<td>Not more than 600～650℃</td>
<td>Angle, Steel tape</td>
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<tr>
<td>(12) Finishing</td>
<td>Finishing of</td>
<td>Surface of weldment</td>
<td>Whole lot Chipping grinder,</td>
<td></td>
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<td>weldment</td>
<td>Being free from slag and</td>
<td>Electric brush hammer</td>
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<td>(13) Member</td>
<td>Measurements of post,</td>
<td>Member shape,</td>
<td>Whole lot Steel ruler,</td>
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<tr>
<td>inspection</td>
<td>brace, and arm members</td>
<td>dimension appearance and</td>
<td>Caliper, Thickness gauge,</td>
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<td>quality</td>
<td>Steel tape measure,</td>
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<td>“Tower manufacturing</td>
<td>Strings</td>
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<td>standard”</td>
<td>Inspection drawing</td>
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<td>Member drawing, Check sheet</td>
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<td>Re-fabrication or correction</td>
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<td>Inspection Sect.</td>
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</tbody>
</table>

**Remarks**
- Heeling standard
- To be inspected by Inspection Sect. staff
- Attention to rapid cooling or heating shall be paid.
- Relative JIS
- To be corrected or scrapped.
- Additional stress relieving
- Manufacturing Sect.
<table>
<thead>
<tr>
<th>Work process</th>
<th>Operational description</th>
<th>Description of the control</th>
<th>Control methods and procedures</th>
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<td>(14) Shop assembly</td>
<td>Shop assembly</td>
<td>Basic dimensions, member fitting and assembly workmanship</td>
<td>&quot;Tower manufacturing standard&quot;</td>
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<td>Dismantling</td>
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<td>(15) Storing and delivery</td>
<td>Delivery of fabricated steel to galvanizing plant</td>
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<td>&quot;Tower manufacturing standard&quot;</td>
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<td>(16) Acceptance before galvanizing</td>
<td>Clients Shapes Piece marks</td>
<td>Amount of rust, grease and paint</td>
<td>Visual inspection</td>
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<td>Surface condition, size, structural detail</td>
<td>Air and zinc passage Weldment</td>
<td>Visual inspection</td>
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<td>(17) Storage of steel being galvanized</td>
<td>Clients, shapes piece marks, sizes and length</td>
<td>Storage of steel by contract number Steel liable to deformation is placed on upper place.</td>
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<td>(18) Preparation of immersion</td>
<td>Clients, piece marks, shapes, sizes and length, Surface condition Structural detail</td>
<td>Setting of steel by identical piece, marks, sizes and length based on galvanizing schedule table</td>
<td>Visual inspection and measurement of length</td>
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<td>(19) Degreasing</td>
<td>Chemicals Concentration</td>
<td>Light clean No. 1010:NaON1:1 40~90g/l</td>
<td>Visual inspection Chemicals analysis</td>
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<td>Residues such as grease and oil</td>
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<td>(21) Pickling</td>
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(22) Water rinsing

Steel surface condition

Residual mill scale and rust

Visual inspection

Each pretreatment bundle

Pretreatment

(23) Care of weldment

Surface condition of weldment

Residual varnish, slag and flux

Visual inspection

Each piece

Pretreatment

(24) Immersion in acid solution

Time

20~40 minutes

Watch

Each bundle

-ditto-

Acid solution for pickling is used.

(25) Water rinsing

Steel surface condition

Visual inspection

-ditto-

-ditto-

To discuss with fabrication plant non-conformance of weldment.
<table>
<thead>
<tr>
<th>Work process</th>
<th>Control item</th>
<th>Control criteria</th>
<th>Method</th>
<th>Lot</th>
<th>Controller</th>
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<th>Kept by</th>
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<tr>
<td>(26) Fluxing</td>
<td>Specific gravity</td>
<td>Large bath 1,125<del>1,155 Small bath 1,200</del>1,130 4.8~5.5</td>
<td>Chemical analysis</td>
<td>Once every shift</td>
<td>Technical Sect.</td>
<td>Treatment solution control data</td>
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<td>(30) Finishing</td>
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<td>Visual and hand feeling check</td>
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<td>Daily supervisor Foreman of galvanizing</td>
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<td>(33) Material allocation</td>
<td>Clients Piece marks Length Shapes</td>
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<td>Each tower type Allocation</td>
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<td>Surplus shortage and non-conformant members are reported to relating sections for corrective action.</td>
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<td>(34) Sorting</td>
<td>Member numbers Piece marks Appearance of galvanized members</td>
<td>Visual inspection</td>
<td>Each tower type Sorting</td>
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<td>Quantity by identical member numbers</td>
<td>Sorting list</td>
<td>Visual inspection</td>
<td>Each tower type</td>
<td>Sorting</td>
<td>Daily work report</td>
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NONCONFORMING label
## NON-CONFORMANCE REPORT

### ABSTRACT

**PROCESS WHICH NON-CONFORMANCE IS OCCURRED OR DISCOVERED**

1. AT MATERIAL ACCEPTANCE  
2. AT MANUFACTURING  
3. AT STORING  
4. AT ERECTING TOWERS AT SITE  
5. OTHERS ( )

### REPORT NO.

- CLIENT NAME:  
- PROJECT NAME:  
- SECT. OCCURRED / DISCOVERED:  
- PERSON ISSUED REPORT:

### SECT. CAUSED NON-CONFORMANCE:

- TYPE:  
- NO.:  
- PART:  
- ITEM NAME:  
- QUANTITY:

### EVALUATION OF NON-CONFORMANT

- A (LIGHT)  
- B (MIDDLE)  
- C (HEAVY)  

### 1. DETAIL DESCRIPTION OF NON-CONFORMANCE

THIS NON-CONFORMANCE HAS BEEN REPORTED TO:
- MANAGER OF Q. A. DEPT.  
- Q. M. REPRESENTATIVE  
- DIRECTOR OF HEADQUATERS  

### EVALUATED AS B / C

- MANAGER OF Q. A. DEPT.  
- Q. M. REPRESENTATIVE  
- DIRECTOR OF HEADQUATERS

### 2. TREATMENT METHOD (DIRECTION OF PERSON DECIDED TREATMENT)

1) TREATMENT METHOD IS:
- REPAIR  
- RE-FABRICATION  
- ADOPTION WITH COMMENT  
- DISUSE

2) RE-INSPECTION AFTER COMPLETION OF TREATMENT:
- WILL BE PERFORMED  
- WILL NOT BE PERFORMED

3) DESCRIPTION OF THE TREATMENT IF ANY OTHER TREATMENT WILL BE PERFORMED:

### RESULT OF RE-INSPECTION:

- PASSED / FAILED  
- OBSERVED:

---

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### CORRECTIVE ACTION REPORT

**REPORT OF REQUEST / COMPLETION ON CORRECTIVE / PREVENTIVE ACTION**

REQUESTED BY MANAGER OF DEPT. / QA QUALITY MANAGEMENT REPRESENTATIVE

**FIRST ISSUE / REISSUE**

<table>
<thead>
<tr>
<th>CORRECTION / PREVENTION</th>
<th>DATE OF ISSUE ;</th>
<th>DATE TO BE RESPONDED ;</th>
<th>PERSON MADE REQUEST</th>
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<tbody>
<tr>
<td>Q. M. R.</td>
<td>M. O. D.</td>
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**BUSINESS CONTROL DEPT., ENGINEERING DEPT., PRODUCTION TECHNOLOGY DEPT., PRODUCTION PLAN CONTROL DEPT., PURCHASING DEPT., NO.1 FACTORY, Q. A. DEPT. MANAGER OF SECT. / DEPT. TO BE REQUESTED ;**

<table>
<thead>
<tr>
<th>DESCRIPTION OF REQUEST</th>
<th>NON-CONFORMANCE PRODUCT</th>
<th>NON-CONFORMANCE SYSTEM</th>
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<tr>
<td>CLIENT NAME</td>
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<tr>
<td>PROJECT NAME</td>
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<tr>
<td>TOWER TYPE</td>
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<td>TOWER NO.</td>
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**DESCRIPTION OF NON-CONFORMANCE**

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**RESPONSE TO**

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<th>RESPONDED DATE ;</th>
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<td>Q. M. R.</td>
<td>M. O. D.</td>
<td>MANAGER</td>
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**CAUSE OF NON-CONFORMANCE**

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<th>PERSON MADE REQUEST</th>
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<td>M. O. D.</td>
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**EVALUATION ON EFFECT OF COUNTERMEASURE**

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<td>M. O. D.</td>
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# MATERIAL DELIVERY NOTE

**DATE:**

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<tr>
<th>MATERIAL REQUISITION</th>
<th>DELIVERY QUANTITY</th>
<th>BALANCE</th>
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<tr>
<td>TOWER TYPE</td>
<td>PIECE MARK</td>
<td>LENGTH (MM)</td>
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<td>CONT. NO.</td>
<td>PROJECT NAME</td>
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**DATE:** [68]