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# ADNOC GROUP PROJECTS AND ENGINEERING

## STRUCTURAL STEEL SUPPLY, FABRICATION AND ERECTION SPECIFICATION

### Specification

AGES-SP-01-002



**GROUP PROJECTS & ENGINEERING / PT&CS DIRECTORATE**

|                  |                                                           |
|------------------|-----------------------------------------------------------|
| <b>CUSTODIAN</b> | Group Projects & Engineering / PT&CS                      |
| <b>ADNOC</b>     | Specification applicable to ADNOC & ADNOC Group Companies |

Group Projects & Engineering is the owner of this Specification and responsible for its custody, maintenance and periodic update.

In addition, Group Projects & Engineering is responsible for communication and distribution of any changes to this Specification and its version control.

This specification will be reviewed and updated in case of any changes affecting the activities described in this document.

## INTER-RELATIONSHIPS AND STAKEHOLDERS

- a) The following are inter-relationships for implementation of this Specification:
  - i. ADNOC Upstream and ADNOC Downstream Directorates and
  - ii. ADNOC Onshore, ADNOC Offshore, ADNOC Sour Gas, ADNOC Gas Processing, ADNOC LNG, ADNOC Refining, ADNOC Fertilisers, Borouge, Al Dhafra Petroleum, Al Yasat
- b) The following are stakeholders for the purpose of this Specification:  
ADNOC PT&CS Directorate.
- c) This Specification has been approved by the ADNOC PT&CS is to be implemented by each ADNOC Group company included above subject to and in accordance with their Delegation of Authority and other governance-related processes in order to ensure compliance
- d) Each ADNOC Group company must establish/nominate a Technical Authority responsible for compliance with this Specification.

## DEFINED TERMS / ABBREVIATIONS / REFERENCES

**“ADNOC”** means Abu Dhabi National Oil Company.

**“ADNOC Group”** means ADNOC together with each company in which ADNOC, directly or indirectly, controls fifty percent (50%) or more of the share capital.

**“Approving Authority”** means the decision-making body or employee with the required authority to approve Policies & Procedures or any changes to it.

**“Business Line Directorates”** or **“BLD”** means a directorate of ADNOC which is responsible for one or more Group Companies reporting to, or operating within the same line of business as, such directorate.

**“Business Support Directorates and Functions”** or **“Non- BLD”** means all the ADNOC functions and the remaining directorates, which are not ADNOC Business Line Directorates.

**“CEO”** means chief executive officer.

**“Group Company”** means any company within the ADNOC Group other than ADNOC.

**“Specification”** means this Structural Steel Supply, Fabrication and Erection Specification.

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## GENERAL

### 1 INTRODUCTION

This specification describes the minimum technical requirements for the fabrication, delivery, erection of structural steel in accordance with the design drawings, approved erection drawings and this specification.

This specification also covers the technical requirements for ladders, platforms, pipe supports, pipe guides associated with the operation and maintenance of horizontal / vertical vessels.

#### 1.1 Purpose

This specification provides minimum requirements for the fabrication, delivery, receipt, handling, erection, assembly and field inspection of structural steel and to maintain work in a safe and stable condition during erection.

This specification also provides the design and fabrication requirements of ladders, platforms, pipe supports, pipe guides associated with equipment by VENDOR for horizontal / vertical vessels.

#### 1.2 Definitions

Where used in this specification, the following terms shall have the meanings indicated below unless otherwise clearly indicated by context of their use.

|            |                                                                                                                                                                                                                                                                                                             |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| COMPANY    | Abu Dhabi National Oil Company or any of its group companies. It may also include an agent or consultant authorized to act for, and on behalf of the COMPANY.                                                                                                                                               |
| CONTRACTOR | The parties that carry out all or part of the design, engineering, procurement, construction, commissioning or management of the PROJECT. CONTRACTOR includes its approved MANUFACTURER(s), VENDOR(s), SUPPLIER(s) and SUBCONTRACTOR(s).                                                                    |
| DESIGNER   | The Engineering Division of the CONTRACTOR or the Consultant which performs the design of the element in question.                                                                                                                                                                                          |
| ERECTOR    | The party that is responsible for the erection of the structural and miscellaneous steel.                                                                                                                                                                                                                   |
| FABRICATOR | The enterprise in charge of detailing and fabrication.                                                                                                                                                                                                                                                      |
| ITP        | Inspection & Test Plan prepared by the CONTRACTOR/ MANUFACTURER, reviewed and approved by COMPANY, highlighting the principal hold and witnessing points during and after the process of the product realization (i.e.: manufacturing, fabrication, construction, installation), to ensure that the quality |

|                                         |                                                                                                                                                                                            |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         | level of the product is within the acceptable design standards and requirements.                                                                                                           |
| MANUFACTURER/<br>VENDOR/SUPPLIER        | The party which manufactures and/or supplies the material/equipment and provides technical documents/drawings and services to perform the duties specified by COMPANY/CONTRACTOR.          |
| MAY                                     | Indicates a permitted option.                                                                                                                                                              |
| PROJECT                                 | To be identified                                                                                                                                                                           |
| PROJECT MANAGEMENT<br>CONSULTANT (PMC)  | Persons, firms, companies, or partnerships appointed by COMPANY to perform PROJECT Management services for the PROJECT, on behalf of the COMPANY.                                          |
| PROJECT MANAGEMENT<br>TEAM (PMT)        | The COMPANY authorized party responsible for the overall day-to-day execution of the Project. The PMT is to serve as the liaison between the COMPANY and the CONTRACTOR(S) on the Project. |
| SHALL                                   | Indicates a mandatory requirement.                                                                                                                                                         |
| SHOULD                                  | Indicates a recommendation                                                                                                                                                                 |
| SUBCONTRACTOR/<br>SUBVENDOR/SUBSUPPLIER | The party(s) which carry(s) out all or part of the design, procurement, installation and testing of the system(s) as specified by the CONTRACTOR/VENDOR.                                   |
| TECHNICAL DEVIATION                     | A deviation requested by the CONTRACTOR, usually after receiving the Contract Package or Purchase Order.                                                                                   |
| TPA                                     | Company contracted to undertake the third-party inspection & verification tasks (TPA) on behalf of ADNOC.                                                                                  |
| WORKS                                   | CONTRACTOR's scope of work                                                                                                                                                                 |
| 1.3                                     | Abbreviations                                                                                                                                                                              |
| AISC                                    | American Institute of Steel Construction                                                                                                                                                   |
| ANSI                                    | American National Standards Institution                                                                                                                                                    |
| ASCE                                    | American Society of Civil Engineers                                                                                                                                                        |
| ASNT                                    | American Society for Non-destructive Testing                                                                                                                                               |
| ASTM                                    | American Society for Testing and Materials                                                                                                                                                 |
| AWS                                     | American Welding Society                                                                                                                                                                   |

|      |                                                |
|------|------------------------------------------------|
| BSI  | British Standards Institute                    |
| DTI  | Direct Tension Indicator                       |
| FRP  | Fibre Reinforced Polymer                       |
| HLU  | Hand-Lay-Up                                    |
| HSE  | Health, Safety & Environment                   |
| ICC  | International Code Council                     |
| ISO  | International Organization for Standardization |
| NDE  | Non-Destructive Examination                    |
| NDT  | Non-Destructive Testing                        |
| PFP  | Passive Fire Protection                        |
| QA   | Quality Assurance                              |
| QC   | Quality Control                                |
| QCP  | Quality Control Plan                           |
| QCR  | Quality Control Record                         |
| RCSC | Research Council on Structural Connections     |
| WPS  | Welding Procedure Specification                |

## SECTION A

### 2 REFERENCE DOCUMENTS

The following Codes and Standards shall form a part of this specification. When an edition date is not indicated for a code or standard, the latest edition at the time of the contract award shall apply.

#### 2.1 International Code(s) and Standards

##### **AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)**

|          |                                                          |
|----------|----------------------------------------------------------|
| AISC 303 | Code of Standard Practice for Steel Buildings and Bridge |
| AISC 325 | Steel Construction Manual                                |
| AISC 326 | Detailing for Steel Construction                         |
| AISC 341 | Seismic Provisions for Structural Steel Buildings        |
| AISC 360 | Specification for Structural Steel Buildings             |

##### **AMERICAN NATIONAL STANDARDS INSTITUTION (ANSI)**

|              |                                                                                 |
|--------------|---------------------------------------------------------------------------------|
| ANSI B1.1    | Unified Inch Screw Threads                                                      |
| ANSI/UL 1709 | Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel |

##### **AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)**

|             |                                                                                 |
|-------------|---------------------------------------------------------------------------------|
| ASCE 7 - 16 | Minimum Design Loads and Associated Criteria for Buildings and Other Structures |
|-------------|---------------------------------------------------------------------------------|

##### **AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)**

|                |                                                                                                                                                                                                              |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASNT SNT-TC-1A | Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Non-destructive Testing, and ASNT-CP- 105: Standard Topical Outlines for Qualification of Non-destructive Testing Personnel |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

##### **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)**

|               |                                                                                                                    |
|---------------|--------------------------------------------------------------------------------------------------------------------|
| ASTM A6/A6M   | Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A36/A36M | Standard Specification for Carbon Structural Steel                                                                 |
| ASTM A53/A53M | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless                     |

|                 |                                                                                                                                                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM A123/A123M | Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products                                                                |
| ASTM A143/A143M | Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement      |
| ASTM A153/A153M | Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware                                                                            |
| ASTM A193/A193M | Standard Specification for Alloy Steel and Stainless-Steel Bolting for High Temperature or High-pressure Service and Other Special Purpose Applications |
| ASTM A194/A194M | Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both         |
| ASTM A307       | Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 psi Tensile Strength                                                   |
| ASTM A320/A320M | Standard Specification for Alloy-Steel and Stainless-Steel Bolting for Low-Temperature Service                                                          |
| ASTM A500/A500M | Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes                                          |
| ASTM A501/A501M | Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing                                                                |
| ASTM A510/A510M | Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel                                      |
| ASTM A563/A563M | Standard Specification for Carbon and Alloy Steel Nuts                                                                                                  |
| ASTM A572/A572M | Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel                                                                  |
| ASTM A653/A653M | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process                        |
| ASTM A673/A673M | Standard Specification for Sampling Procedure for Impact Testing of Structural Steel                                                                    |
| ASTM A759       | Standard Specification for Carbon Steel Crane Rails                                                                                                     |
| ASTM A786/A786M | Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy and Alloy Steel Floor Plates                                           |
| ASTM A992/A992M | Standard Specification for Structural steel Shapes                                                                                                      |

|                   |                                                                                                                                                                                                                                                |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM A1001        | Standard Specification for High Strength Steel Castings in Heavy Sections                                                                                                                                                                      |
| ASTM A1011/A1011M | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength                                                         |
| ASTM B209/B209M   | Standard Specification for Aluminium and Aluminium-Alloy Sheet and Plate                                                                                                                                                                       |
| ASTM B695         | Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel                                                                                                                                                           |
| ASTM C954         | Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness                                                  |
| ASTM C1007        | Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories                                                                                                                             |
| ASTM C1513        | Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections                                                                                                                                                      |
| ASTM F436/F436M   | Standard Specification for Hardened Steel Washers Inch and Metric Dimension                                                                                                                                                                    |
| ASTM F606/F606M   | Standard Test methods for Determining the mechanical properties of Externally and Internally Threaded fasteners, Washers, Direct Tension Indicators, and rivets                                                                                |
| ASTM F959/F959M   | Standard Specification for Compressible - Washer - Type Direct Tension Indicators for use with Structural Fasteners, Inch and Metric Series                                                                                                    |
| ASTM F3125/F3125M | Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120ksi and 150ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength |

#### **AMERICAN WELDING SOCIETY PUBLICATIONS (AWS)**

|                |                                                                        |
|----------------|------------------------------------------------------------------------|
| AWS A2.4       | Standard Symbols for Welding, Brazing, and Non-destructive Examination |
| AWS D1.1/D1.1M | Structural Welding Code – Steel                                        |
| AWS QC1        | Specification for AWS Certification of Welding Inspectors              |

#### **BRITISH STANDARDS INSTITUTE (BSI)**

|           |                                                                                                                                                             |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BS 476-20 | Fire Tests on Building Materials and Structures - Part 20: Method for Determination of the Fire Resistance of Elements of Construction (General Principles) |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|

|           |                                                                                                                                                     |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| BS 476-21 | Fire Tests on Building Materials and Structures - Part 21: Methods for Determination of the Fire Resistance of Loadbearing Elements of Construction |
| BS 3083   | Specification for hot-dip zinc coated and hot-dip Aluminium/Zinc Coated corrugated steel sheets for general purposes                                |
| BS 4190   | ISO Metric Black Hexagon Bolts, Screws and Nuts – Specification                                                                                     |
| BS 4592-0 | Flooring, stair treads and handrails for industrial use - Part 0: Common design requirements and recommendations for installation                   |
| BS 4592-1 | Industrial type flooring and stair treads – Part 1: Metal open bar gratings – Specification                                                         |
| BS 4592-5 | Industrial type flooring and stair treads - Part 5: Solid plates in metal and glass reinforced plastics (GRP) - Specification                       |
| BS 4868   | Specification for Profiled aluminium sheet for building                                                                                             |
| BS 5427   | Code of practice for the use of profiled sheet for roof and wall cladding on buildings                                                              |
| BS 5493   | Code of practice for Protective Coating of Iron and Steel Structures against corrosion                                                              |
| BS 7668   | Weldable Structural Steels - Hot Finished Structural Hollow Sections in Weather Resistant Steels - Specification                                    |

#### **EUROCODES (BS EN)**

|                             |                                                                                                            |
|-----------------------------|------------------------------------------------------------------------------------------------------------|
| BS EN 1090-2                | Execution of steel structures and aluminium structures Part 2: Technical requirements for steel structures |
| BS EN 1592<br>(Parts 1 - 4) | Aluminium and Aluminium Alloys – HF Seam Welded Tubes                                                      |
| BS EN 1991-1-4              | Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions                               |
| BS EN 1993-1-1              | Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings                   |
| BS EN 1993-1-5              | Eurocode 3 - Design of steel structures Part 1-5: Plated structural elements                               |
| BS EN 1993-1-8              | Eurocode 3: Design of steel structures - Part 1-8: Design of joints                                        |
| BS EN 1993-1-10             | Eurocode 3: Design of steel structures - Part 1-10: Material toughness and through-thickness properties    |
| BS EN 1993-5                | Eurocode 3 - Design of steel structures - Part 5: Piling                                                   |

|                              |                                                                                                                                                                                                                                                                 |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BS EN 1993-6                 | Eurocode 3 - Design of steel structures - Part 6: Crane supporting structures                                                                                                                                                                                   |
| BS EN 10025<br>(Parts 1 - 6) | Hot Rolled products of Structural Steels                                                                                                                                                                                                                        |
| BS EN 10029                  | Hot-rolled steel plates 3 mm thick or above - Tolerances on dimensions and shape                                                                                                                                                                                |
| BS EN 10056-1                | Structural steel equal and unequal leg angles - Part 1: Dimensions                                                                                                                                                                                              |
| BS EN 10204                  | Metallic products Types of inspection documents                                                                                                                                                                                                                 |
| BS EN 10210-1                | Hot Finished Structural Hollow Sections of Non-Alloy and Fine Grain Steels Part 1: Technical delivery condition                                                                                                                                                 |
| BS EN 10210-2                | Hot finished steel structural hollow sections Part 2: Tolerances, dimensions and sectional properties                                                                                                                                                           |
| BS EN 10225<br>(Parts 1 - 4) | Weldable structural steels for fixed offshore structures—Technical delivery conditions                                                                                                                                                                          |
| BS EN 10269                  | Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties                                                                                                                                                                |
| BS EN 10365                  | Hot rolled steel channels, I and H sections – Dimensions and masses                                                                                                                                                                                             |
| BS EN 13381-8                | Test methods for determining the contribution to the fire resistance of structural members Part 8: Applied reactive protection to steel members                                                                                                                 |
| BS EN 14399<br>(Parts 1 - 6) | High-Strength Structural Bolting assemblies for preloading                                                                                                                                                                                                      |
| BS EN ISO 148-1              | Metallic materials - Charpy pendulum impact test Part 1: Test method                                                                                                                                                                                            |
| BS EN ISO 8501-1             | Preparation of Steel Substrates before Application of Paints and Related Products; Visual Assessment of Surface Cleanliness, Rust Grades and Preparation Grades of uncoated Steel Substrates and of Steel Substrates after overall removal of previous coatings |

#### **GERMAN INSTITUTE FOR STANDARDIZATION**

|            |                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------|
| DIN 1025-1 | Hot rolled I-sections - Part 1: Narrow flange I-sections, I-series - Dimensions, masses, sectional properties |
|------------|---------------------------------------------------------------------------------------------------------------|

#### **INTERNATIONAL CODE COUNCIL (ICC)**

|       |                                       |
|-------|---------------------------------------|
| IBC   | International Building Code           |
| ADIBC | Abu Dhabi International Building Code |

### INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

|           |                                                                                                                                                                               |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ISO 898-1 | Mechanical properties of fasteners made of carbon steel and alloy steel Part 1: Bolts, screws and studs with specified property classes - Coarse thread and fine pitch thread |
| ISO 898-2 | Mechanical properties of fasteners made of carbon steel and alloy steel - Part 2: Nuts with specified property classes - Coarse thread and fine pitch thread                  |
| ISO 4032  | Hexagon regular nuts (style 1) - Product grades A and B                                                                                                                       |
| ISO 7089  | Plain Washers - Normal Series - Product Grade A                                                                                                                               |
| ISO 9001  | Quality Management Systems – Requirements                                                                                                                                     |
| ISO 9004  | Quality management – Quality of an organization – Guidance to achieve sustained success                                                                                       |

### RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

|                |                                                               |
|----------------|---------------------------------------------------------------|
| RCSC Committee | Specification for Structural Joints Using High-Strength Bolts |
| RCSC Committee | Specification for Structural Joints Using A325 or A490 Bolts  |

#### 2.2 ADNOC Specifications

The following ADNOC general specifications, as available with respective Group Company and as applicable to the Project, shall form a part of this specification. When an edition date is not indicated for a document, the latest edition in force at the time of contract award shall apply.

|                                                 |                |
|-------------------------------------------------|----------------|
| Concrete Supply & Construction Specification    | AGES-SP-01-001 |
| Structural Design Basis – Onshore Specification | AGES-SP-01-003 |
| Prefabricated Metal Buildings                   |                |
| Anchor Bolts & Grouting                         |                |
| Thermal and Moisture Protection                 |                |
| Painting                                        |                |
| Galvanizing                                     |                |
| Fire Proofing                                   |                |
| Preservation and Export Packing                 |                |

### 2.3 ADNOC Standard Drawings

The following ADNOC standard drawings, as available with respective Group Company and as applicable to the Project, shall form a part of this specification. When an edition date is not indicated for a document, the latest edition in force at the time of contract award shall apply.

Steel Works General Notes

Anchor Bolts Material-Fabrication-Marking

Anchor Bolt Details

Fireproofing Details

Ladders / Ladder Details

Ladder Attachment on Cold Vessels (< -20°C) in Operation

Stairways

Handrail Details

Brackets for Platforms

Brackets for Platforms on Vessels

Brackets for Platforms on Cold Vessels (<-20°C) in Operation

## 3 DOCUMENTS PRECEDENCE

It shall be the CONTRACTOR's responsibility to be, or to become, knowledgeable of the requirements of the referenced Codes and Standards.

The CONTRACTOR shall notify the COMPANY of any apparent conflict between this specification, design drawings, the related data sheets, the Codes and Standards and any other ADNOC General Specifications noted herein. Resolution and/or interpretation of precedence shall be obtained from the COMPANY in writing before proceeding with the design/manufacture.

In the event of a conflict between documents, the following hierarchy of adherence shall be followed:

1. UAE Statutory Legislation and Regulations
2. ADNOC Code of Practices
3. Purchase Order or Contract documents including Project drawings and Specifications
4. COMPANY General Specifications and Standards
5. International Codes and Standards

In case of conflict between documents in the same level of hierarchy, the most stringent requirement shall apply. Such interpretation of the most stringent requirement shall be subject to COMPANY's approval utilizing a technical query sheet. In all such cases of conflict, COMPANY's decision shall be final.

#### 4 TECHNICAL DEVIATION CONTROL

Any technical deviations to the Purchase Order and its attachments including, but not limited to, the COMPANY's General Specifications shall be sought by the CONTRACTOR only through Technical Deviation Request Format. Technical Deviation requires COMPANY's review/approval, prior to the proposed technical changes being implemented. Technical changes implemented prior to the COMPANY's approval are subject to rejection.

#### 5 QUALITY PLANS

##### 5.1 General

Quality plans shall address all aspects related to local conditions, such as climatic conditions, backup facilities, spare parts, transport possibilities, storage facilities, quarries, local Manufacturer/Suppliers, test facilities (field laboratory).

Quality Management Systems shall comply with the applicable requirements of BS EN ISO 9001 "Quality Management Systems- Requirements" and BS EN ISO 9004, "Quality management – Quality of an organization – Guidance to achieve sustained success". Written quality plans and procedures shall be submitted to the COMPANY for review and approval.

Materials should be obtained from the same source(s) throughout the work (including both trial and production mixes).

##### 5.2 Inspection, Testing and Reporting

- a) Inspection and Test Plans (ITPs) identifying the tests, frequencies, acceptance criteria, and responsibilities shall be prepared as part of the quality plan.
- b) A reporting system of Quality Control Records (QCRs) shall be part of the quality plan.
- c) The reporting system shall record all results obtained during the testing.
- d) Weather conditions shall be recorded in the quality records.
- e) The proposed ITPs and QCRs shall be included in the Quality Plan.
- f) Standard forms of inspection and test plans shall be used as a basis for the development of the ITPs and QCRs supplemented by the requirements of the specifications for the work to be executed.
- g) The COMPANY reserves the right to make inspections of the source of supply of materials.
- h) Prior to supply of any material to site the CONTRACTOR shall obtain COMPANY approval by submitting necessary documentation such as test certificates, source of supply, date of manufacture, etc.

### 5.3 Quality Control and Assurance

CONTRACTOR shall be solely responsible for quality control of all materials and workmanship. The quality system shall provide for the planned and systematic control of all quality-related activities performed during design, fabrication and erection of steel structures. Implementation of the quality system shall be in accordance with the Project Agreement, CONTRACTOR's approved Quality Manual and Project Specific Quality plan.

The CONTRACTOR shall ensure that the FABRICATOR/VENDOR/MANUFACTURER shall always have in effect, a QA/QC program, which clearly establishes the authority and responsibilities of those responsible for the quality system. Persons performing quality functions shall have sufficient and well-defined authority to enforce quality requirements that they initiate or identify and to recommend and provide solutions for quality problems and thereafter verify the effectiveness of the corrective action.

Quality System and Quality Control requirements shall be identified and included in the CONTRACTOR's Purchase documentation. Based on these requirements, the FABRICATOR/VENDOR/MANUFACTURER will develop a QA/QC program, which shall be submitted to the COMPANY/CONTRACTOR for review and concurrence. The FABRICATOR/MANUFACTURER/VENDOR's QA/QC program shall extend to SUBCONTRACTOR'S/SUBVENDOR's.

The CONTRACTOR shall submit certified reports of all tests as soon as the tests are completed satisfactorily.

COMPANY/CONTRACTOR reserves the right to inspect or to conduct a quality audit of materials, installation and workmanship standards and shall have unrestricted entry to the shop of the fabricator at all stages of manufacture and to witness any or all tests. The FABRICATOR/VENDOR/MANUFACTURER, 30 days after award but prior to the pre-inspection meeting, shall provide the COMPANY/CONTRACTOR with a copy of its Manufacturing and Inspection Plan for review and inclusion of any mandatory COMPANY/CONTRACTOR witness or hold points.

The COMPANY/CONTRACTOR may reject improper, inferior, defective, or unsuitable materials, installation and workmanship. All materials and workmanship rejected shall be repaired or replaced by the FABRICATOR as directed by the COMPANY.

CONTRACTOR to develop the Criticality Rating (CR) System the design checking levels and minimum requirements for shop inspection, testing and material certification. CONTRACTOR shall develop a list of Criticality ratings for all equipment items. Regardless of the Criticality Rating COMPANY/CONTRACTOR shall review the FABRICATOR'S/VENDOR'S documentation to ensure compliance with the requirements of the AGREEMENT.

## SECTION B

### 6 TECHNICAL REQUIREMENTS

Not Applicable.

### 7 ADDITIONAL SPECIFIC REQUIREMENTS

Not Applicable.

## SECTION C

### 8 MATERIAL

Materials, codes and standards listed in sections 8.2 to 8.9 in this specification shall be used. The use of alternative codes, standards or materials is not permitted unless it has been approved by COMPANY.

#### 8.1 Certification

CONTRACTOR/FABRICATOR is responsible to supply materials conforming to the following codes and standards, including all material certificates/testing. Mill test reports covering chemical and physical properties for each type of steel, grating and bolts shall be included.

Materials heat number to be cross referenced and traceable with Mill test certification. Inspection certificate Type 3.1 (BS EN 10204 reference) shall be provided for COMPANY approval.

#### 8.2 Structural Steel

Structural steel material, Grades and shapes shall be in accordance with any one set of the following American Standards or equivalent British Standards, as shown in items (a) & (b) below:

##### a) ASTM Standards:

- 1) Structural Steel Grade to A36/A36M or A572/A572M Grade 50 [345].
- 2) A6/A6M (General requirements).
- 3) ASTM A501/A501M Grade A or B (Hot formed Steel tubing for Structural applications).
- 4) ASTM A53, Type E or S, Grade B (Steel Pipes - hollow round shapes with relatively thicker wall thickness than round tubing).
- 5) ASTM A992/A992M (Structural Steel W and WT).

##### b) BS Standards:

- 1) Structural Steel Grade S275JR to BS EN 10025-1 to 6 or S355JR to BS EN 10025-1 to 6
- 2) Structural Hollow Sections (round, square, rectangular shapes) Steel grade S275JOH/ S275J2H or S355JOH/ S355J2H to BS EN 10210-1 & 2
- 3) Structural Pipes Sections (Steel Pipes - hollow round shapes with relatively thicker wall thickness than round tubing) Steel grade S275JOH/ S275J2H to BS EN 10210-1 & 2
- 4) BSI BS EN 10365 / DIN 1025-1 (Structural Steel Sections)
- 5) Angles conform to BS EN 10056-1
- 6) Plates to BS EN 10029

- c) The use of high strength steel grades where required in specific situations are subject to COMPANY approval. When high strength steel grades (A572/572M Grade 50 or S355JR) are used CONTRACTOR shall ensure that the use of higher-grade steel should not impede the structural integrity with respect to serviceability criteria (vibration, deflection/drift, etc.), reduced structural stiffness and minimum thickness requirements to cover corrosion issues.
- d) Charpy V-notch impact tests shall be conducted for all structural steel grades used as primary steel in accordance with standard Specification ASTM A673/A673M or BS EN ISO 148.
- e) Single grade/standard shall be used for the whole structure. Only new material to be used, no re-use or re-cycling of previously used material. All structural steel materials shall be subject to COMPANY approval.
- f) FABRICATOR to provide physical marking of grade of steel, to allow for easy identification during field modification and future expansion.

### 8.3 Bolts, Nuts and Washers

MANUFACTURER is responsible to supply bolts, nuts and washers and all material certificates / testing. All these items shall be as per the following American Standards or equivalent British Standards shown in items (a) & (b) below:

#### a) ASTM Standards:

- 1) High-strength bolt assemblies
  - i) Bolts as per ASTM F3125 / F3125M Grade A325 Type 1 or Grade A490/A490M Type 1
  - ii) Washer as per ASTM F436/F436M
  - iii) Heavy Hex Nut/Thread as per ASTM A563 Grade DH
  - iv) Direct Tension Indicator (DTI) washers as per ASTM F959/F959M
- 2) Standard bolt assemblies for tertiary steel
  - i) Bolts as per ASTM A307 Grade A
  - ii) Washer as per ASTM F436/F436M
  - iii) Heavy Hex Nut/Thread as per ASTM A563 Grade A
- 3) Bolts for Low temperature:
  - i) Bolts for low temperature (-50 degrees C or below) shall be as per the following American Standards. Bolts shall be in accordance with ASTM A320/A320 M Grade L7. Nuts shall be in accordance with ASTM A194/A194 M Grade 7 and Washers shall be in accordance with ASTM F436 / F436M.

#### b) BS Standards:

- 1) High-strength bolt assemblies:
  - i) Bolts as per Grade 8.8 or equivalent in accordance with ISO 898-1 and ISO 898-2
  - ii) Heavy Hex Nut/Thread as per ISO 4032
  - iii) Washer as per ISO 7089, or BS EN 14399-6

- iv) Or Bolting assemblies as per BS 4190 Grade 8.8
- 2) Standard bolt assemblies for tertiary steel
  - i) Bolts as per Grade 4.6 or equivalent in accordance with ISO 898-1 and ISO 898-2
  - ii) Heavy Hex Nut/Thread as per ISO 4032
  - iii) Washer as per BS EN 14399-6
  - iv) Or Bolting assemblies as per BS 4190 Grade 4.6
- 3) Bolts for Low temperature
  - i) Bolts and assemblies for low temperature (-50 degrees C or below) shall be as per BS EN 10269.
- 4) High Strength Friction Grip Connections
  - i) ISO 898-2 high-strength friction-grip connections, grade 10.9 or equivalent, may be used for transport or lifting applications or other special applications, subject to approval by the COMPANY.
  - ii) ISO 898-2 high-strength friction-grip (pretension bolts) shall not be used for steel connection that are required for gravity or other sustained load conditions, because of their loss of pre-tension in a fire.
- c) Bolt grade higher than 8.8 (such as 10.9 and A490 etc.) can be used if it is required as per the design in certain cases, subject to COMPANY Approval.
- d) Bolts, nuts and washers shall be hot-dipped galvanized in accordance with COMPANY specification for Galvanizing, except Grade A490/A490M bolts which shall be coated as recommended in ASTM F3125/F3125M and COMPANY specification for Painting. The exposed ends of galvanized bolt assemblies shall be repaired in accordance with COMPANY specification for Galvanizing and Painting.
- e) Hot-dipped galvanizing shall comply with ASTM A153/A153M & ASTM A563/A563M, Class C. Mechanical galvanizing shall be in accordance with ASTM B695. Nuts shall be tapped oversize, according to ASTM A563, prior to galvanizing and then retapped again after galvanizing, mechanically galvanized nuts need not be retapped. Surface preparation shall be in accordance with COMPANY specification for Galvanizing and Painting.
- f) Load indicator washers shall be mechanically galvanized in accordance with ASTM B695, Class 50.
- g) Mixing of different bolt material grade (like, BS, ASTM etc.) in the same structure is not allowed.
- h) A minimum of 5% extra quantities of each bolt size and length, including nuts and washers, shall be provided to cover requirements for fit-up and erection.
- i) For anchor bolt materials, design and details, refer to COMPANY specification for Anchor Bolts.

#### 8.4 Open Grid Flooring/Metal Grating

- a) Welded-steel bar grating shall be Grade S275 JR as per BS 4592-1 or ASTM A1011 / A1011M. Open Grid Flooring/ Metal Grating shall be serrated welded grating rectangular open grid type with bearing bars 30mm x 5mm thick at 30mm cross centre and 6 x 6 twisted cross bars at 100mm cross centre, hot dip galvanized after fabrication. Cross bars shall be welded to the upper edge of the load bearing bars. Galvanizing shall be in accordance with the COMPANY specification for Galvanizing.
- b) Electro forged grating shall be Grade S275 JR and conform to BS EN 10025. Grating shall be manufactured as per BS4592-1 or ASTM A36 / A36M or ASTM A1011 / A1011M. Electro forged Grating shall be serrated rectangular open grid type with bearing bars 30mm x 5mm thick at 30mm cross centre and 6 x 6 twisted cross bars at 100mm cross centre. Electro forged grating can be used subject to COMPANY approval.
- c) Banding bars shall be of the same thickness as the bearing bars to which they are welded.

#### 8.5 Stair Treads

- a) Welded-steel bar grating stair treads shall be Grade S275 JR as per BS 4592-1 or ASTM A1011 / A1011M. Stair treads shall be serrated rectangular pattern open grid type, with 30mm x 5mm bearing bars at 30mm cross centre, 6 x 6 mm twisted bars at 100mm cross centre, and non-skid abrasive nosing, hot dip galvanized after fabrication. Cross bars shall be welded to the upper edge of the load bearing bars. Galvanizing shall be in accordance with the COMPANY specification for Galvanizing. Stair treads shall be bolted to the stair stringer.
- b) Electro forged grating shall be Grade S275 JR and conform to BS EN 10025, Grating shall be manufactured as per BS4592-1 or ASTM A36 / A36M or ASTM A1011 / A1011M. Electro forged Grating type shall be serrated rectangular open grid type with bearing bars 30mm x 5mm thick at 30mm cross centre and 6 x 6 twisted cross bars at 100mm cross centre. Electro forged grating can be used subject to COMPANY approval.

#### 8.6 Floor Plates

- a) Chequered-floor plate shall be raised four-way standard as per ASTM A786/786M, Pattern 4 or Pattern 5 and ASTM Grade A36 / A36M or BS4592 - Parts 0 & 5. Plates shall be hot dip galvanised.
- b) Banding and toe plate banding as per ASTM Grade A36 / A36M or ASTM A1011 / A1011M.
- c) Floor plate / Chequered Plate shall be skid resistant and minimum of 6mm thick excluding the height of raised pattern. Tear shaped pattern: 8 x 30 x 2mm.

#### 8.7 Welding Electrodes

All welding electrodes as per AWS D1.1/D1.1M and shall be Low hydrogen with an electrode strength of 400 MPa (58ksi) minimum yield strength and 480 MPa (70ksi) minimum tensile strength.

All filler material shall be selected to match the mechanical and chemical requirements of the base materials to be joined, unless otherwise specified or agreed by COMPANY in writing.

Filler metals for welding materials of differing strengths and toughness together shall be required to develop only the same strength and toughness as the lower quality member.

#### 8.8 Ladders, Cages and Handrails

- a) Ladder and rungs shall conform to BS EN 10025 Grade S275JR or ASTM Grade A36/A36M.
- b) Ladder rungs shall be of 20mm diameter.
- c) Handrail shall be as per ASTM A53 / A53M Grade B or ASTM A500 / A500M Grade B or BS EN 10210 Grade S275 JR and size as per COMPANY standard drawing.

#### 8.9 FRP Gratings, Stair Treads, Handrails and Ladders

Fibre-Reinforced Polymer (FRP) grating, stair treads, handrails and ladders may be used for specific applications if approved by the COMPANY.

The final material selection shall take into account the possible effects of a hydrocarbon fire. It is not permitted to apply these materials for personnel access facilities in Fireproofing zones of hydrocarbon processing plants.

Their use at locations with a high corrosion rate may be considered such as for instance at water intake or outfall stations, water treatment plants, catwalks between a jetty trestle or loading platform and dolphins.

FRP Gratings shall be manufactured with premium vinyl ester resin using the Open Mould-Compression Moulding Process or open mould, hand-lay-up (HLU) process combined with the incorporation a system of weighted compressions of the glass into the un-cured resin at multiple stages during the panel's manufacture. The glass content of moulded gratings shall be 32.5% by weight, +/-2.5%.

The grating shall be minimum 38mm thick with square mesh of size 38mm x 38mm.

Handrails and ladders (vertical posts, horizontal rails, kick plates, ladder rails, and ladder rungs) shall be manufactured from pultruded structural shapes. Ladder hoop rings shall be manufactured using a hand-lay-up (HLU) process. The vertical cage slats may also be manufactured from hand-lay-up (HLU) process or by the pultrusion process.

All hardware for attaching FRP items shall be 316 Stainless Steel. If 316 SS bolts penetrate through a carbon steel flange, a non-metallic isolation sleeve or rubber coating shall be used around the bolt in the interface region to eliminate dissimilar metal corrosion.

## 9 DESIGN AND DETAILING

### 9.1 General

- a) All design and drawings shall be as per the provisions of relevant COMPANY specifications and the listed Codes/Standards.

- b) FABRICATOR shall be responsible for correct interpretation of design drawings when established by CONTRACTOR to enable FABRICATOR to prepare calculation notes for connections and shop drawings.
- c) No deviation from design drawings shall be made without COMPANY's approval in writing.
- d) The steel shapes to be fireproofed and/or galvanized shall be clearly marked on the shop and CONTRACTOR's drawings.
- e) FABRICATOR shall be solely responsible for detailing and fabrication so that erection will be convenient and free from all interferences, drilling or cutting on site. The FABRICATOR shall provide erection and fabrication drawings.
- f) FABRICATOR shall be responsible for dimensions and strength of details (FABRICATOR's designed connections) not shown on design drawings.
- g) All calculations and drawings shall be in S.I. units.
- h) Shop drawings shall take into account agreed practical transportation measures concerning the size of shop assembled or individual pieces of steel work.
- i) All FABRICATOR's documents shall refer to the relevant approved design drawing numbers and revisions. This information shall be clearly shown near the title drawing block.
- j) Structures shall be designed and constructed such that the joints / nodes are accessible for inspection, cleaning and painting.
- k) Pockets or depressions, which could collect and hold water, shall have drain holes to protect from corrosion due to standing water.
- l) When fabrication and delivery can be expedited by the substitution of shapes for members shown on the design drawings, such substitutions shall be submitted with supporting design calculations, test reports and all necessary documents for COMPANY approval prior to fabrication.
- m) The design of connection shall be based on the following:
  - 1) Design, detailing, and fabrication of Bolted or welded connection shall be in accordance with either AISC's Allowable Strength Design (ASD) or Load and Resistance Factor Design (LRFD) method, as specified in contract documents.
  - 2) Bolted connection design shall be in accordance with the RCSC specification for structural joints using high-strength bolts, AISC 325, and AISC 326 or BS EN 1993-1-8.
  - 3) Welded connection design shall be in accordance with ANSI/AISC 360, AISC 325, and AISC 326 or BS EN 1993-1-8.
  - 4) Bolted and Welded Connection Design Forces:  
Design of connections shall be based on the greater of the following:
    - i) Actual design loads (member end reactions) as per the final and approved structural design drawings.

- ii) For Moment Connections: 60% moment capacity of the member with 50% shear capacity of the member plus axial tension of 5% tensile capacity of the member calculated using gross cross section.
  - iii) For Shear Connections: 50% of the shear capacity of the member plus axial tension of 5% tensile capacity of the member calculated using gross cross section.
- 5) Bracing Connection Design Forces:
 

Design of connections shall be based on the greater of the following:

  - i) Actual design loads (member end reactions) as per the final and approved structural design drawings.
  - ii) 50% of the allowable tension capacity of the member calculated using gross cross section.
  - iii) 27kN tension.
- n) Minimum thickness of steel plates shall be as below:
  - 1) Minimum thickness of gusset plate or bar (excluding floor plate) shall be 10mm and gusset plate shall not be thinner than the member to be connected.
  - 2) The minimum thickness for stiffeners shall be 8mm and stiffener plate shall not be thinner than the member to be connected.
  - 3) The minimum thickness of clips, cap plate and end plate shall be 10mm.
- o) The edge distance for bolts in bracing members, in the directions of the force, shall comply with AISC Steel Construction Manual, Table J3.4/J3.4M or BS EN 1993-1-8, Section 3.5 - Table 3.3 requirements.
- p) Load sharing shall not be considered between bolts and welds within the same joint.
- q) Double angle bracing elements shall not be used unless specifically permitted / approved by COMPANY.
- r) Shop connections may be welded or bolted.
- s) Field connections shall be bolted, unless otherwise shown on the drawings.
- t) Columns splices shall be detailed and designed by CONTRACTOR/FABRICATOR to develop full strength of the column (irrespective of the slenderness ratio and actual forces/ moments at the splice location). All column splice shall be field-bolted and shall be in accordance with AISC 326.
- u) All other members shall not be spliced unless specifically authorized by the COMPANY in writing. Design and details for splices shall be provided by the CONTRACTOR.
- v) For each individual member or part to be joined, shop drawings shall be detailed with the following:
  - 1) All fasteners sizes, arrangement, dimensions, quantities and grades.
  - 2) All connection material and weld types, sizes, and lengths.

- w) All shop drawings including erection drawings shall be submitted by FABRICATOR to the CONTRACTOR for review and approval. Only checked, signed and approved drawings will be accepted by the COMPANY. The connection design calculations shall be submitted for COMPANY review and approval. COMPANY'S review will be general verification of design methodology and shall not imply verification of arrangement, dimensions, or quantities.
- x) Prior to steel shipment, furnish the field with four complete full-size sets of approved erection and shop drawings for each shipment, erection segment or shop order.
- y) The CONTRACTOR shall develop applicable procedure to issue the necessary documentation for the field (drawings, bill of material, shipping lists, bolting lists, etc.).
- z) All welding symbols shall be in accordance with AWS A2.4 and all shop drawings shall show the AWS joint designation number for all pre-qualified welds.

## 9.2 Welded Connections

- a) Welded Connection design shall conform to AWS D1.1/D1.1M.
- b) The minimum fillet weld size shall be 6mm for structural welds, except that the weld size need not exceed the thickness of the thinner part joined.
- c) Seal welds shall be a minimum of 3mm fillet weld.
- d) Welds to connection plates embedded in concrete shall be deposited in a sequence that limits the distortion of the embedment to less than 3 mm.
- e) Butt joints with square welds, unless shown on the CONTRACTOR's design drawings, are not allowed without prior written COMPANY's/CONTRACTOR's authorization.
- f) All welds shall be continuous and intermittent welding is not allowed.
- g) FABRICATOR shall design web thickening plates if notching of beam flanges will reduce the remaining effective web cross section below the area required for the beam connection design shear force.
- h) Connection of column flanges to base plates shall be full penetration welds. Webs to base plates shall be continuous fillet weld with minimum size of 0.35 times web thickness or 6mm whichever is higher. Continuous fillet weld of column flanges with minimum size of 0.35 times flange thickness or 6mm whichever is higher, may be permitted by COMPANY for specific cases.
- i) The design of erection clips for field-welded connection shall be submitted to the COMPANY for approval.
- j) Erection clips for fit-up of welded connections shall be provided by the CONTRACTOR.
- k) Welded structural load bearing connections where the through thickness of material is subjected to tensile stress shall be prohibited unless shown on the CONTRACTOR's drawings.

### 9.3 Bolted Connections

- a) All bolted connections shall be bearing type with threads included in the shear plane, except the connections which are subjected to vibration or stress reversal shall be friction grip type bolts. All bolted connections exposed to dynamic loads and vibrations shall be provided with lock nuts (e.g., supporting machinery, crane beams, flare stacks, masts). Friction grip bolts shall not be used for sustained loads.
- b) Joints subject to Fatigue Cycles and Large Temperature Variations shall be designed and detailed accordingly.
- c) High strength bolts of 20mm minimum diameter shall be used for the connections of main structural members such as framing, splices, tie beams, bracings etc.
- d) Standard bolts of 16mm minimum diameter shall be used for purlin, girt, door frame, handrail and ladders.
- e) Standard bolts of 12mm minimum diameter shall be used for floor plates, ladder cages, stair treads, and toe plates.
- f) Minimum Number of Bolts per connection shall be based on the following:
  - 1) Bracing connections shall have a minimum 2 Nos. of bolts. For bracings/ members 200mm deep and more, a minimum of 4 Nos. of bolts shall be provided at each end of the bracings/ members.
  - 2) All cross-bracing connections shall be bolted at intersections with a one-bolt minimum for angles and two bolts minimum for tees.
  - 3) "Pinned" beam connections shall preferably have end plates with a minimum of 4 Nos. bolts, except for stability bracing or floor supporting heavy equipment.
  - 4) For cantilevered bracket, the tie and the knee bracing member connection with the column shall be by means of an end plate with minimum 4 Nos. of bolts, regardless of the size of the member.
- g) Unless otherwise specified on the drawings, Standard, Oversize or Slotted hole diameter shall be as indicated in Table J3.3M of the AISC Steel Construction Manual or Section 6.6 and Table 11 of BS EN 1090-2. All Bolt holes shall be drilled to their final diameter. Flame cutting of holes shall be prohibited. Connections requiring new holes in existing steel shall be drilled or punched.
- h) For framed-beam slip-critical connections, oversized or horizontal short-slotted holes may be used in the outstanding leg of clip angles.
- i) For framed beam bearing connections, horizontal short-slotted holes as defined in Table J3.3M of the AISC Steel Construction Manual may be used in the outstanding leg of clip angles if approved by COMPANY.
- j) For slotted holes, the long direction of the slot shall be perpendicular to the load direction, unless otherwise noted in the drawings.

- k) Standard bolt and high strength bolt assemblies for standard holes shall have a minimum one hardened washer and a heavy hex nut.
- l) Standard bolt and high strength bolt assemblies for oversized or slotted holes, shall have a hardened washer under all bolt heads and /or nuts adjacent to any ply with oversized or slotted hole and a heavy hex nut. Expansion joints shall have 2 washers (1 each side) and a locking nut.
- m) Standard bolts for all bearing joints shall be installed as Snug Tightened Joints. A snug tight condition is the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the connected plies into firm contact.
- n) High strength bolts for all bearing joints shall be installed in accordance with AISC/RCSC "Specification for Structural Joints Using High Strength Bolts". Fully tensioned (bearing or slip-critical) bolts are required as per the AISC Specification Section J1.10 and RCSC Specification Section 4.2.
- o) Direct tension indicator washers shall be used for friction grip bolts and where specified in the design drawings, standards or specifications. Tighten friction grip bolts using turn-of-the-nut method to achieve required bolt tension in strict accordance with RCSC Specification for Structural Joints Using A325 or A490 Bolts or equivalent British Standards. Retighten as required to achieve proper bolt tension for all bolts.
- p) Bolts and load indicator washers shall not be re-used. Re-tightening bolts is not considered as reuse provided the snugging-up continues from the initial position and does not require a greater rotation required by RCSC Specification for Structural Joints using A325 or A490 Bolts.
- q) All nuts for high-strength bolts shall be wax-dipped to reduce torque during installation.
- r) All bolt lengths shall be determined in accordance with the commentary on RCSC Specification for Structural Joints using High-Strength Bolts, Table C-2.2.
- s) The thread length of the bolts shall be adequate to ensure that the nuts are entirely engaged. Minimum of 2 threads pitches extended beyond the top surface of the nut.
- t) The length of the smooth cylindrical part of the bolt shall not be less than 0.85 the sum of the thickness of the members to be bolted.
- u) Clip angle (cleat) connection shall be shop bolted and field tightened. Shop bolts shall be manually tightened to allow for field adjustment prior to pre-tensioning.
- v) Rail splice and crane girder splice shall not coincide with each other.
- w) Crane rail joints shall be staggered.

#### 9.4 Ladders, Stairs and Platforms

##### 9.4.1 General

- a) Ladders, stairs and platforms along with pipe supports, guides and brackets associated with equipment shall be designed and detailed in accordance with relevant COMPANY specifications and standard drawings.
- b) Design, arrangement and minimum width of platforms, walkways, stairs and ladders shall comply with HSE and operational requirements stipulated by COMPANY.
- c) Minimum headroom above platforms, walkways and stairways shall be 2100 mm to the lowest point of any overhead obstruction. The horizontal travel distance from any point on platform to an emergency escape (stair or ladder) shall not exceed 20m
- d) Ladders accessed frequently due to operational requirements shall be provided with a suitable anti-slip covering (UV resistant) for rungs.

#### 9.4.2 Platforms on vessel/equipment

- a) The CONTRACTOR shall be responsible for verifying the loads imposed by ladders, platforms, pipe supports, etc. on the vessel shell or head in accordance with the requirements noted in this Specification and COMPANY Specification for Structural Design Basis.
- b) Stairs shall be provided instead of ladders in areas where HSE concerns require personnel to wear air-breathing apparatus when entering. Ladders with cages shall not be used in these areas unless approved by the COMPANY.

## 10 FABRICATION

### 10.1 General

- a) Fabrication and assembly shall comply with the requirements of the AISC Specification/ BS Standards, except as amended by this specification.
- b) Dimensional tolerances shall follow Tables 1-22 through 1-29 of AISC Steel Construction Manual. Also see AWS D1.1/D1.1M.
- c) Fabrication of stairs, ladders, cages and handrails shall be in accordance with approved design drawings and COMPANY standard drawings.
- d) Ladders and cages shall be shop-assembled to the greatest extent possible within shipping limitations. Ladder cages shall be assembled on ladders. Safety gates shall be tagged, shipped loose and securely wired to corresponding handrail with #9 wire.
- e) Platforms, stairways and handrails shall be shop-assembled in the largest unit suitable for handling, shipping and erection. Platforms on columns shall be systematically shop-assembled to avoid unnecessary adjustments on site.
- f) Handrail assemblies (consisting of handrails and knee-rails welded to handrail posts) shall be shop assembled to the greatest extent possible within shipping limitations. Handrail shall be shop attached to platforms whenever practical. Handrail that cannot be shop attached to platforms shall be shop assembled in sections for field bolting to platforms.

- g) Shop-assembly by welding shall be the maximum compatible with type of transport from workshop to site.
- h) Panels for open grid flooring and floor plates shall be fabricated with span ends occurring over structural framing.
- i) Panels for open grid flooring and floor plates which have shop-made cut-outs shall be split on the centreline of the openings. All openings 200mm in diameter or 250mm in diagonal and larger shall be banded with a toe plate.
- j) All beams, except cantilevers, shall be fabricated with natural mill camber in the up position.
- k) A positive camber of 10mm (3/8 in) for every 5 m (16 ft - 6 in) span shall be applied if the total span of a structure or frame exceeds 20 m (65 ft - 7 in).
- l) Material procured shall be thoroughly straightened in the shop by methods that do not cause damage before it is laid aside or worked in any way.
- m) The COMPANY reserves the right to reject any unsatisfactory materials and misfit members resulting from errors in shop detailing, fabrication, painting, or galvanizing. Any such errors which prevent the proper assembly of the structure and require correction or adjustment shall be rectified by the FABRICATOR/CONTRACTOR at no extra cost to the COMPANY. The proposed correction technique and method statement shall be submitted for COMPANY approval prior to implementation.
- n) CONTRACTOR shall have Quality plan, Quality control procedure, including Quality Control Records (QCR's), method statements, safety procedures, records of quality control inspection test reports and test results in place, prior to fabrication.

## 10.2 Bolting

- a) The required locking devices, if noted on the drawings, shall be provided.
- b) Mechanically galvanized bolts or nuts shall not be interchanged with hot dipped galvanized nuts or bolts, respectively.
- c) When two structural members on opposite sides of a column web, or a beam web over a column, are connected sharing common connection holes, the FABRICATOR shall provide a means of supporting one member while erecting the other member. Unless the means of support is indicated in the drawings, the FABRICATOR may provide:
  - 1) One additional row of bolts in the member to be erected first.
  - 2) An erection seat for the member to be erected first, unless additional loading is indicated.

The erection seat shall be sized and attached to the column or supporting beam web with sufficient bolts to support the dead weight of the member.

### 10.3 Welding

- a) Welding, including details and drawings, procedures, qualification of personnel, consumables, workmanship, quality testing and inspection, shall comply in every respect with the requirements of AWS D1.1/D1.1M Code.
- b) A certification of qualification shall be submitted for each welder, welding operator, and tacker employed on the work in accordance with the requirements of AWS.
- c) Temperature of base metal to be welded shall conform to minimum preheat and interpass temperatures outlines in AWS D1.1 for the appropriate welding process and steel specification.
- d) All shop welding shall be performed in an area protected from adverse weather conditions (rain, wind) and air-born dust and sand.
- e) Parts to be welded shall be carefully prepared and be firmly held before welding to avoid, as far as possible, warping, buckling and residual stresses.
- f) Tack welds shall be made in at least two passes such that filler metal is deposited over the whole thickness of the joint.
- g) Weld profiles shall be controlled by gauges in accordance with the relevant standards.
- h) Tack welds not incorporated in the final weld shall be removed by grinding after completion of the work in order to produce a smooth regular finish.
- i) Prior to the beginning of the work, the FABRICATOR shall submit to the CONTRACTOR a Welding Procedure Specification (WPS) to include the following:
  - 1) Method of preparing the parts to be welded (clearances, tolerances,).
  - 2) Location, type, size of welds and effective length of welds.
  - 3) Details of non-standard welds.
  - 4) Where seal welds are required with details.
  - 5) Type and extent of inspection including any special inspection requirements.
  - 6) Welding supervisor and welders shall be qualified in accordance with the relevant AW codes and they will have qualification certificates available for review.
  - 7) Specification and grade of parent metal.
  - 8) Classification of consumables.
  - 9) Welding consumables certificates.
  - 10) Electrodes certificates.
  - 11) Quality of welds and inspection.
  - 12) All items shown on AWS D1.1/D1.1M Forms M-1 to M-8, Annex M.
  - 13) A unique identification number for each WPS.
  - 14) AWS joint designation number for pre-qualified welds.

- 15) All additional information to be shown on weld maps using AWS symbols and terminology.
- j) The quantity and the type of control shall follow the requirements of AWS code, indicated on design drawing or specified by the CONTRACTOR representative in workshop.
- k) Welds at butt joints noted on drawings shall be subjected to radiographic examination in the shop. Welds at butt joints performed by automatic or semi-automatic welding shall be subjected to the above-mentioned examination. Ultrasonic Testing in lieu of radiographic testing can be specified for the following:
- 1) Wall Thickness > 10mm
  - 2) Full penetration welds
  - 3) Fatigue / Critical welds

Ultrasonic testing is capable of identifying planar defects, details of such defects are important parameter for weld joints that are subject to Engineering Criticality Assessment (ECE).

Additionally, Ultrasonic testing technique possess no health risk i.e. no radiation hazard, no requirement of exclusion zone while carrying out NDE.

Radiographic testing is a volumetric NDE method which can be specified for fillet weld arrangements, wall thickness < 10mm, or configuration that limits the use of ultrasonic testing such NDE welds shall be subject to COMPANY approval.

For acceptance criteria of (NDE), Non-destructive examination of welds, refer to clause 13.3 (h).

- l) Run-off bars and extension tabs shall be removed before corrosion protection coatings are applied or before being sent to the field for erection.
- m) All welding procedures, whether pre-qualified or not, shall be submitted to the COMPANY for authorization. Welding shall not start until these documents are returned with COMPANY approval.
- n) Welding sequence and procedures shall be such as to minimize distortion and shrinkage. Where required by the design drawings, welded assemblies shall be stress relieved by heat treating.

#### 10.4 Grating and Floor Plate

- a) Grating shall span in only one direction.
- b) In order to avoid installation error, square grating panels should not be fabricated.
- c) Grating shall be removable, unless otherwise specified.
- d) Removable floor plate or grating sections shall not exceed 65kg (140 lbs). However, the maximum weight to be manually lifted by one person shall be 23kg.
- e) A 12 mm (1/2 inch) diameter drainage hole shall be provided for each 2 square meter of floor plate area, with a minimum of 1 hole per panel prior to galvanizing. The edges of the hole shall have same surface protection as required for remainder of floor plate.

- f) Grating/chequered plate openings dimensioned on the design drawings shall be cut and banded in the shop as shown on the design drawing.
- g) Holes or cut-outs in panels shall be made by the flooring MANUFACTURER and have perimeter stiffening strips welded in. This work shall be completed before galvanizing.
- h) The following location shall be trim banded, except item 5 which shall be load-carrying banded:
  - 1) Open ends of grating at head of ladder approach to platform
  - 2) All openings in grating.
  - 3) All hinged sections.
  - 4) Grating panels with four or less cross bars.
  - 5) All cut outs having unsupported bearing bars.
- i) The fasteners will be supplied with 5 percent extra to cover losses. The installation of clamps/ fasteners shall be done by the ERECTOR.

#### 10.5 Finishing/Protection

- a) All protection for structural steel works (Galvanizing/Painting) shall be in accordance with COMPANY specification for Galvanizing and Painting.
- b) Prior to galvanizing or shop priming, all sharp corners, burrs (including bolt hole burrs), weld spatter, slag, weld flux, loose mill scale and other foreign matter shall be removed.
- c) Upon completion of fabrication, all surfaces of structural steel not noted otherwise are to be blasted and primed by FABRICATOR according to COMPANY specification for Galvanizing and Painting.
- d) Top rails of handrails, ladder rungs, rails and cages shall be smooth and free of burrs, sharp edges and weld spatter.
- e) All cuts shall be neat, clean and free of warping, cracking and burrs. Edges and holes shall be deburred and rounded off. All re-entrant corners shall be shaped, notched-free, to a radius.
- f) Provisions shall be made for inaccessible surfaces after assembly - such surfaces shall be painted before assembly.
- g) The fireproofing system where required shall be as per relevant COMPANY Specification and standard drawings. The PFP material shall have certification as tested and qualified to UL 1709 or BS EN 13381-8 or BS 476-20/21 requirements for fire rating to protect structural steel.
- h) Steel with passive fire protection shall be provided with appropriate weather protection to avoid steel corrosion issues.
- i) Bolted / welded connection block-outs for shop fireproofed members shall be in accordance with relevant COMPANY Specification and standard drawing.

- j) The connection of hand railing, stairs, ladders, and bracing (for angle only) fabricated on fire-proofed beam/columns shall be located outside the fireproofing.
- k) Gusset plates for vertical or horizontal bracing members and single-plate shear connections for beams shall extend beyond the fireproofing to make the connection with the fireproofing in place.
- l) The PFP material MANUFACTURER/SUPPLIER recommended anti-corrosion primer shall always be used to avoid any compatibility and corrosion issues under PFP system.
- m) All surfaces of existing steel structure to be used for connection to new structures shall be prepared on site as follows:
  - 1) Prepare surfaces in accordance with BS 5493 by on site abrasive sand blasting to remove loose/damaged old paint, rust, salt, fouling, loose or flaking rust or other foreign matter from the surface of the steel.
  - 2) Clean the exposed steel surfaces but unpolished to BS EN ISO 8501-1, grade St2.
  - 3) Prime bare steel without delay. In locations where, existing welded steel members have been removed, it shall be ensured that all fins, burrs, sharp edges, weld, loose rust and scale are removed.
  - 4) Grind off area to bare steel around each joint prior to application of full protective system.
  - 5) The protective system shall be as required for the new structure, but surface of existing coatings shall be tested for compatibility prior to full application and COMPANY approval shall be obtained.

## 11 ERECTION

### 11.1 General

- a) All tools, equipment and ropes used for erection shall comply with local regulations and certified for the purpose intended.
- b) A daily erection record of all material erected shall be kept by the CONTRACTOR and organized by piece number.
- c) Any circumstances (for example discrepancies between the erection/shop drawings and the delivered steel members, or Incorrectly fabricated steel members) that affect progression, performance, or completion of the erection work activities, shall be immediately reported to the CONTRACTOR and the COMPANY in writing and recorded in the daily erection record.
- d) Before commencing work, the MANUFACTURER/SUPPLIER shall survey and check foundations and other connection points to confirm their location, orientation, elevation, and condition.
- e) If there is incomplete or unacceptable work that affects the erection, it shall be immediately reported to the COMPANY in writing and recorded in the daily erection record.

- f) Temporary erection loads, or permanent loads shall not be placed, or any incomplete portions of the structure being erected, unless approved by the COMPANY.
- g) Loose timbers, metal sheeting, bolt buckles, tools, debris, the temporary scaffolding shall be kept restrained or removed from work areas.
- h) Lifting of painted structural members shall be done with a nonabrasive chocker.
- i) The MANUFACTURER/SUPPLIER shall be responsible for:
  - 1) Setting out of the works and for accurately positioning, plumbing, lining and levelling of all steelwork in accordance with the drawing.
  - 2) Unless otherwise specified, maintaining following tolerances for erection of structural steelwork: Levelling  $\pm 3$  mm (1/8 in); Alignment and plumb  $\pm 3$  mm (1/8 in).
- j) Any galvanizing and painting which becomes damaged shall be repaired in accordance with the COMPANY Specification for Galvanizing and Painting.
- k) Plug weld unused holes.
- l) The procedures and specifications to repair all sags, deformations, holes, and other irregularities shall be submitted to the COMPANY/CONTRACTOR for approval.
- m) Repairs, alterations, or changes to structural steel members shall not be made without DESIGNER and COMPANY's written approval.

#### 11.2 Pre-Erection

- a) CONTRACTOR shall submit erection plan for COMPANY's review and approval. It shall include all related aspects not limited to, sequence of erection, details of temporary arrangements, details of equipment/ tools to be used with their certification and position during erection activities, etc.
- b) Examine the areas and conditions under which work of this Specification will be performed. Correct the conditions which are detrimental to proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.
- c) Establish permanent benchmarks necessary for the accurate erection of structural steel. Check elevations of concrete and locations of anchor bolts and similar items, before erection proceeds.
- d) After receipt of structural bolts at site, CONTRACTOR shall carry out testing of the bolts as indicated in this specification or as instructed by the COMPANY. Structural bolting shall commence only after review and approval of test results by COMPANY.

#### 11.3 Erection and Alignment

- a) Erection of structural steel, grating, stair treads, and floor plates shall be performed in accordance with the AISC Specification for Structural Steel Buildings, AISC Code of Standard Practice for Steel Buildings and Bridges, AISC Steel Construction Manual or equivalent British Standards and this specification.

- b) Set structural frames accurately to the lines and elevations indicated on the Drawings. Align and adjust the various members forming a part of a complete frame or structure before fastening permanently. No permanent bolting or welding shall be executed until correct position and alignment has been achieved.

c) Tolerances

- 1) The tolerances on position and alignment of member working points and working lines are as follows:

Erection tolerances are defined relative to member working points and working lines as follows (Refer to AISC Code of Standard Practice for Steel Buildings and Bridges) unless noted otherwise on the design drawings:

- i) For members other than horizontal member, the member work point is the actual centre of the member at each end of the shipping piece.
- ii) For horizontal members, the working point is the actual centre line of the top flange or top surface at each end.
- iii) Other working points may be substituted for ease of reference, providing they are based upon these definitions.
- iv) The member working line is a straight line connecting the member working points. Individual column shipping pieces are considered plumb if the deviation of the working line from a plumb line does not exceed 1:500, subject to the following limitations:
  - a) The member working points of column shipping pieces adjacent to elevator shafts may be displaced no more than 25mm from the established column line in the first 75m.
  - b) The member working points of exterior column shipping pieces may be displaced from the established column line no more than 25mm toward nor 51mm away from the building line in the first 75m.
  - c) The member working points of exterior column shipping pieces at any splice level for multi-tier buildings and at the tops of columns for single tier buildings may not fall outside a horizontal envelope, parallel to the building line, 38mm wide for buildings up to 91.5m in length. The width of the envelope may be increased by 13 mm for each additional 30.5m in length but may not exceed 76mm.
  - d) The member working points of exterior column shipping pieces may be displaced from the established column line, in a direction parallel to the building line, no more than 51mm in the first 75m.

- 2) The alignment and position of members other than columns shall be as follows:

- i) Alignment of members which consist of a single straight shipping piece containing no field splices, except cantilever members, is considered acceptable if the variation in alignment is caused solely by the variation of column alignment and/or primary supporting member alignment within the permissible limits for fabrication and erection of such members.
- ii) The elevation of members connecting to columns is considered acceptable if the distance from the member working point to the upper milled splice line of the column does not deviate more than plus 5mm or minus 8mm from the distance specified on the drawings.

- iii) The elevation of members which consist of a single shipping piece, other than members connected to columns, is considered acceptable if the variation in actual elevation is caused solely by the variation in elevation of the supporting members which are within permissible limits for fabrication and erection of such members.
  - iv) Individual shipping pieces which are segments of field assembled units containing field splices between points of support are considered plumb, level and aligned if the angular variation of the working line of each shipping piece relative to the plan alignment does not exceed 1:500.
  - v) The elevation and alignment of cantilever members shall be considered plumb, level and aligned if the angular variation of the working line form a straight line extended in the plan direction from the working point at its supported end does not exceed 1:500.
  - vi) The elevation and alignment of members which are of irregular shape shall be considered plumb, level and aligned if the fabricated member is within its tolerance and its supporting member or members are within the tolerances specified in this Specification.
- 3) The tolerances on position and alignment of lintels, wall supports, curb angles, mullions and similar supporting members are as follows:
  - i) Adjustable items are considered to be properly located in their vertical position when their location is within 10 mm of the location established from the upper milled splice line of the nearest column to the support location as specified on the drawings.
  - ii) Adjustable items are considered to be properly located in their horizontal position when their location is within 10 mm of the proper location relative to the established finish line at any particular floor.
- d) Base Plates and Anchor Bolts
  - 1) CONTRACTOR to prepare surfaces to ensure full contact between column end & base plate top surface.
  - 2) Scabble/chip concrete bearing surfaces for base plates to a depth of 6mm minimum to improve bond and expose aggregate. Concrete surfaces shall be free from laitance, oil, grease, loose materials or other foreign material prior to start of field erection. The top of bearing surfaces and the bottom of base plates shall be cleaned before erection.
  - 3) Provide shims or wedges where required. Shims are to be placed with a minimum of 40mm clear distance for non-stainless-steel shims and a minimum of 20mm clear distance for stainless steel shims from the edge of the base or bearing plate prior to grouting.
  - 4) Column base plates shall be set and shim to correct positions, elevations, and locations as shown on the erection drawings.
  - 5) If setting nuts are used, loosen them after installing shims or wedges.
  - 6) Structure shall be plumbed, levelled, and braced before any final bolted or welded connections are made and before grouting of base plates and tightening anchor bolts.
  - 7) Set loose attached base plates and bearing plates for structural member on adjustable devices. Install adequate shim packs to distribute loads without overstressing base or bearing plates or the foundation if grouting is to be delayed until after steel erection.
  - 8) Unless otherwise specified in contract documents, grout base plates and bearing plates including furnishing of materials in accordance with COMPANY specification for Grouting. No voids between bearing surfaces and bases or plates shall remain after grouting is

complete. Fill shear key openings with grout. Fill anchor sleeves with grout only if specified in contract documents. Chamfer or cut off exposed edges of grout at 45 degrees after grout has acquired its initial set as applicable.

- 9) After grout has reached design strength, remove temporary shims or wedges and grout void space.
  - 10) Finish exposed grout surfaces, protect installed materials, and allow to cure in strict compliance with the MANUFACTURER's instructions. Retighten anchor bolts as required.
  - 11) If required as part of the design, fully tighten anchors to specified tension as per PROJECT document.
  - 12) Anchor shall be fully tightened to specified tension only after base plates been grouted and grout has sufficiently set in accordance with MANUFACTURER's recommendations.
- e) Clean the bearing surfaces of all items which will be in permanent contact before assembly.
- f) Provide temporary shoring, braces and guys as required to achieve proper alignment and maintain stability. Erected steel shall be adequately braced to resist Dead, Erection, Construction and Wind Loads until permanently connected and self-supported. The CONTRACTOR is responsible for the stability of the structures during erection. Guys and temporary bracings shall be designed to withstand all loads to which the structure may be subjected during erection.
- g) Provide temporary planking and working platforms of sufficient strength as needed for effective completion of the work of the Specification.
- h) Grating and floor plates
- 1) The method for fastening grating and floor plate shall be as specified on the design drawings.
  - 2) Open Grid Flooring/ Metal Grating shall be attached to the supporting steelwork with a minimum of 2 clamps at each support. Minimum 4 Nos. clamps shall be used for fixing each grating panel (in case of large panels, use minimum 4 Nos. clamps per square meter).
  - 3) The installation of clamps/ fasteners shall be done by the ERECTOR.
  - 4) Joints perpendicular to the span of grating and chequered plate flooring shall occur only over supports.
  - 5) To secure the grating panels in position and to prevent its sliding in case of clamp failures, 2 Nos. of 25 mm deep x 5mm wide x 50mm long flat plates to form 'L' shape (or) 2 Nos. M8 stud fasteners each at 50 mm from the corner of grating (at right angle) shall be shop welded at the top of supporting beams at each corner of the grating panel.
  - 6) Floor plates shall be welded to steel supporting members with 40mm long x 5 mm fillet welds at 200mm centres, except floor plates indicated as removable on the design drawings.
  - 7) Removable floor plate sections shall be fastened to supporting members on all sides (minimum 2-M12 bolts per side) with flush countersunk bolts spaced 300mm maximum on centres.
  - 8) Stiffeners for floor plates shall be provided if required based on span/loading consideration.
  - 9) The fixing of grating to the fire proofed steel beam shall be from top side of top flange instead of conventional type hook supported from bottom side of top flange.
  - 10) A nominal gap of 8mm shall be provided between installed plates.

- 11) Openings in Grating shall have a minimum clearance of 25 mm.
  - 12) All grating penetrations of size 200mm and above shall be shown on design drawings, cut-out in the shop and banded with toe plate (collar).
  - 13) After installation of grating elements, all openings shall be covered with properly fixed plywood or other suitable material.
  - 14) Band all field cut outs in grating and floor plates using kick plate at least 5mm thick. Attach kick plate by welding. Kick (collar) plate shall be provided by ERECTOR unless otherwise noted.
- i) If required, the SUBCONTRACTOR may perform reaming and cutting to allow proper fit-up of structural steel members in accordance with section 11.5 of this specification. Any major fabrication errors which prevent the proper assembly of the structure must be immediately reported to the COMPANY and to the SUPPLIER. The SUPPLIER/CONTRACTOR is responsible to correct the error. The SUPPLIER will submit a proposed correction technique and method statement for approval of the CONTRACTOR/ COMPANY. Drift pins shall be used only to bring members into alignment. Do not flame cut holes or enlarge holes by burning.
  - j) Column splices having gaps of 2mm to 6mm with less than 70 percent contact between bearing surfaces shall be packed with non-tapered steel shims. Gaps greater than 6mm are not acceptable and shall be rectified with corrective action approved by COMPANY.
  - k) Provide the services of a licensed surveyor or experienced civil engineer acceptable to the COMPANY to survey the erection of structural steel concurrently with the erection progress. The survey shall verify that the finish structure conforms to lines and elevations shown on the Drawings within the tolerances specified in the AISC Code of Standard Practices or in this specification.
  - l) Touch-up of Protective Coatings
    - 1) Method of erection shall minimize damage to painted or galvanized surfaces.
    - 2) Touch-up painted surfaces damaged during erection and areas left unpainted for erection purposes in accordance with the COMPANY specification for Painting.
    - 3) Touch-up galvanized surfaces damaged during erection in accordance with the COMPANY specification for Painting.
  - m) Fireproofing
    - 1) Fireproofing for bolted/welded connection block-outs where applicable, shall be in accordance with the COMPANY Specification for Fireproofing and Standard Drawing for Fireproofing Details. Anchor bolts to be covered with fireproofing shall be adequately isolated with suitable material as per VENDOR recommendation and COMPANY approval.
    - 2) Fireproofing damaged during erection shall be repaired in accordance with the COMPANY Specification for Fireproofing.
  - n) The CONTRACTOR shall notify the COMPANY of any steel not erected because of his oversight, neglect, for his convenience or due to unavailability of the material to be erected at the jobsite. The CONTRACTOR shall continue the work with the material on hand. However, this shall in no way endanger either the job or personnel. Unavailable material shall be erected by the Contractor when it arrives at the job site.

- o) The erection of certain members as indicated on the design drawings may have to be deferred to facilitate the installation of mechanical components or items of equipment. The CONTRACTOR, as part of the work shall complete the erection of structural steel after the equipment is in place.
- p) Structures or parts thereof and material included therein, indicating irremediable or injurious defect, improper fabrication and excessive repair not in accordance with the specification shall be subject to rejection. They shall also be subject to rejection if such conditions are discovered after acceptance of the SUBCONTRACTOR's works.

#### 11.4 Erection – Bolted Connection and Field Welding

##### a) Bolted Connection

- 1) Bolted connection shall be in accordance with this specification.
- 2) Mechanically galvanized bolts and nuts shall not be intermixed with hot-dip galvanized nuts and bolts.
- 3) The MANUFACTURER/SUPPLIER shall colour code, die punch, or otherwise mark the ends of torqued bolts indicating that the bolts have been properly tensioned and are ready for inspection.
- 4) "Squirter" Type equivalent DTI washers should be used to ease inspection.
- 5) Method of measuring bolt pre-tensioning shall be subject to approval by the COMPANY.
- 6) Some of the available methods of bolt pretension measurement are twist-off, "Squirter" Type DTI, or turn-of-the nut method.
- 7) Bolt heads and nuts shall bear squarely against metal underneath. Install bevelled washers under bolt heads or nuts bearing on flanges with slopes greater than 1 to 20.
- 8) Nuts and bolts shall be tightened in a staggered pattern. Where there are more than four bolts in any joint, they shall be tightened from the centre of the joint to free edges outwards. If erection bolts are used, they shall be replaced with permanent bolts as soon as possible after aligning the structure to plumb.

##### b) Field Welding

- 1) Field welding is not allowed unless it is indicated on the erection drawings or approved by COMPANY. Field welding where approved by COMPANY or indicated on the erection drawings shall be in accordance with this specification.
- 2) All field welding will be indicated on the detailed design and erection drawings. Welding, including procedures, appearance, and quality of welds, and methods for correcting welding work, shall be in conformance with AWS D1.1/D1.1M and prequalified procedures accepted by the CONTRACTOR/ COMPANY. Procedures that must be qualified as required by AWS D.1, Section 5 shall be submitted to the DESIGNER for authorization and then to the COMPANY for approval. Welding shall not start until these documents are returned to the CONTRACTOR approved.

#### 11.5 Erection – Connection Errors

- a) Fit up bolts and drift pins shall not be used to bring improperly fabricated members and parts into place (springing).
- b) When approved by the COMPANY, standard holes may be enlarged by 1 mm (1/16 in) when necessary to make connections resulting from minor misfit.
- c) Holes in connections that misfit by more than 1 mm (1/16 in) shall be corrected unless otherwise approved by the COMPANY.
- d) Enlargement of holes shall be made by reaming or drilling only.
- e) Flame cutting, burning, gouging, chipping, or drift punching shall not be permitted.
- f) The use of gas cutting torches in the field for correcting fabricating errors in the structural framing is not permitted.
- g) No packing, shimming, filling, or wedging shall be permitted to correct faulty work unless otherwise approved by the COMPANY.

#### 11.6 Erection and Shop Drawings

- a) Erection drawings shall reference the corresponding design documents; shop drawings shall reference the corresponding erection drawings.
- b) Shop drawings shall clearly show the specification and grade of steel to be used.
- c) Erection and shop drawings shall be grouped in sets and identified separately for each building, structure, or yard area.
- d) Shop drawings shall state the welding electrode to be used.
- e) Surface preparation and shop applied coatings, including areas to be masked, shall be noted on the shop drawings.
- f) In the event that drawing revisions are necessary, the shop drawings shall clearly be clouded showing all changes of the latest revisions.
- g) Shop drawings and erection drawings shall be prepared using a three-dimensional steel modelling and detailing software system. All miscellaneous steel such as handrail, guards, stairs, and ladders shall be included in the same three-dimensional model as main structural steel and detailed using the same system.

## 12 ADDITIONAL REQUIREMENTS FOR STEEL BUILDING/SHELTERS

### 12.1 Frame

- a) The structural framework shall be rolled structural shapes or welded plate sections (columns and rafters only). Cold formed shapes are not acceptable for main structures.

- b) Cold formed steel members can be used for members such as cladding purlins and girts, the minimum thickness shall be 2mm. However, cold formed sections are not permitted in case purlins/girts are supporting concrete slab or any utilities (such as pipes, cables, ducts, etc.).
- c) The building shall be rigid frame type with pinned or fixed column bases.
- d) Rigid frames shall be designed according to COMPANY specification for Structural Design Basis. Provisions shall be made to prevent lateral movement of the compression flange of the knee. Knee construction may be either straight hunched, curved hunched, straight knee or made of tapered or trapezoidal hunched sections. Splices shall be designed for the capacity of the member. The location of the splice may be proposed at the option of the FABRICATOR for CONTRACTOR / COMPANY approval.
- e) Minimum roof slope shall be 15%. However, lesser slope shall be followed based on the approval from the COMPANY.
- f) The flange width of member supporting lightweight concrete slabs shall be not less than 80 mm.
- g) For supporting roof sheeting and wall cladding, the flange width shall be not less than 50 mm.
- h) Purlins shall be fixed to the roof beams or trusses by means of angle cleats.
- i) Floor and Roof deck sheets shall be installed in accordance with the sheet metal MANUFACTURER's installation instructions and the design drawings.
- j) Frame tolerances in accordance with AISC for Steel Buildings and Bridges or BS EN 1090-2 and BS EN 1993-1-1.

## 12.2 Metal Cladding

### 12.2.1 General

- a) Where no thermal insulation and/or no sound absorption are required, cladding shall be single skin, in the other case it shall be double skin. Refer to Engineering drawings.
- b) Where required, roof and wall sound absorbing cladding to machinery shelters shall have an acoustic insulation value of at least 25 db.
- c) Where buildings exposed to blast overpressure aluminium sheeting shall not be used.
- d) The selection of sheeting material type shall be subject to COMPANY approval.

### 12.2.2 Material

The metal cladding characteristics shall be as follows:

- a) Single skin aluminium/ steel sheet

- 1) Both sides PVDF (3 layers) coated aluminium/ steel profiled sheets. PVDF coating thickness is 25µm and test standard as per BS EN 13523-1. Aluminium sheets shall conform to ASTM B209/B209M having minimum yield strength of 115MPa or equivalent (Alloy 3003 & Temper H14) or BS 4868 and minimum thickness of 0.9mm. Steel sheets conforming to ASTM A653/653M having minimum yield strength of 345MPa or equivalent (Base metal CS type A & coating Z275) or BS 3083 shall be 0.7mm thickness.
- 2) The use of Colour coat PVDF in distinctly marine and heavily industrialised environments is not recommended. For Harsh environmental conditions one of the following 2 coating systems is recommended:
  - i) Colour coat Prisma - Solid, Metallic & Matts. Thickness of Colour coat Prisma - Solid, Metallic & Matts is 65µm (15µm additional protective clear layer, 25µm coloured layer with polyamide beads and 25µm corrosion resistant primer) and test as per BS EN 13523-1.
  - OR
  - ii) Colour coat Prisma – Elements. Thickness of Colour coat Prisma - Elements is 40µm (10µm additional protective clear or coloured layer, 20µm coloured or base polymer layer and 10µm corrosion resistant primer) and test as per BS EN 13523-1.
- 3) Profiled metal sheet shall have a 45mm minimum depth of ribs.
- 4) Flashing shall be manufactured from aluminium/steel and factory coated similar to cladding sheets.
- 5) All sheeting and flashing end laps shall be fastened with stainless steel self-tapping screws. Sheets shall be fixed at not less than three screws per meter.
- 6) Fasteners shall be stainless steel weathered drive screws with plastic cup washer to match cladding colour.
- 7) Colour of cladding shall match existing buildings, according to COMPANY requirements and as per the adopted colour code of each site. Internal colour of the cladding shall be white. Colour of cladding shall be indicated on Engineering Drawings.
- b) Double Skinned Insulated cladding panel (with corrugated exterior face)
  - 1) Insulated cladding panels shall be of 100mm nominal thickness (thickness of insulation at minimum depth of panel profile) with injected polyisocyanurate foam insulation between exterior and interior metal skins. Metal skins of 0.7mm thick for exterior skin composite of aluminium with 3 layers of PVDF coating (PVDF coating, thickness and other coating type as per section 12.2.2 - Clause a - 1 & 2 in this specification) and 0.5mm thick for interior skin composite of polyester coated GI steel.
  - 2) For the types and specifications of double skinned insulated cladding panels, refer to COMPANY Specification for Thermal and Moisture Protection.
- c) Translucent Sheets
  - 1) Translucent panels shall be minimum 1.4mm thick and composed of fire retardant, light stabilized polyester resin and glass reinforcement fabricated in a configuration matching perfectly that of the exterior/adjacent metal cladding.
  - 2) They shall be of uniform section, colour, translucency and finish.

- 3) Profile shall match that of the adjacent metal cladding.
  - 4) Sheets shall be coated with UV resistant Melinex film and having 30% glass content.
  - 5) The light transmission of sheets shall be 85% to 90%.
- d) All gutters, roof vents and downspouts shall be pre-coated galvanized sheet metal to ASTM 123/ A123M and A143/A143M or of aluminium, as approved by the COMPANY.
- e) Louvers shall be made of anodized aluminium.
- f) The following accessories shall be provided as aluminium or galvanized and coated steel of suitable thickness approved by the COMPANY:
- 1) Sheet metal parapet caps
  - 2) Flashings
  - 3) Base trims
  - 4) End trims
  - 5) Other trims associated with metal panels joints

#### 12.2.3 Workmanship

- a) Cladding, fasteners, trims and related items shall be erected according to the shop/installation drawings and in accordance with the MANUFACTURER's instructions/specifications.
- b) Cladding elements shall be properly seated and aligned with neighbouring elements. Flashings and fixings shall be straight and in line.
- c) Cladding panels shall be protected from factory to installation and thereafter protected from damage in place. Methods of protection shall be agreed.
- d) At wall penetration (pipelines, ducts, conducts, etc..) cladding shall be provided with cut outs and field cut where required. Weather-tight two pieces closures shall be installed with factory formed devices matching the colour of the cladding.
- e) Where applicable, the building shall be naturally ventilated by a continuous ridge vent in galvanized sheet and coated to match cladding.
- f) Metal louvers shall be installed where necessary for intake/exhaust. Exact location shall be shown on drawings. A peripheral waterproofing sealant shall be installed around exterior frame.

#### 12.2.4 Cladding Fixing Design Requirements

- a) The cladding MANUFACTURER shall calculate all the applicable design loads seismic loads, blast loads (in case of blast-resistant building) and wind loads as per Chapter-30 Wind Loads: Components and Cladding of ASCE-7 2016 or BSI BS EN 1991-1-4 and as per the COMPANY specification for structural design basis. The design calculations shall be submitted for COMPANY approval prior to fabrication.

- b) Primary fasteners shall be manufactured from stainless steel grade 316 and shall be of the self-drilling type, sized and spaced as recommended by the cladding MANUFACTURER to ensure that the fasteners are capable of withstanding the design, dead, imposed and wind loads acting on the cladding. The primary fasteners shall have a minimum thread diameter of 5.5mm and spacing not greater than 300mm, unless more stringent requirements are recommended by the cladding MANUFACTURER based on design.
- c) Secondary fasteners shall be used for sheet side lap stitching and for securing flashings and ancillary components of the cladding. Stitching fasteners shall be of the self-drilling or self-tapping threaded type and shall be manufactured from stainless steel grade 316.
- d) The secondary fasteners shall have a minimum thread diameter of 4.8mm. The spacing of stitch fasteners where required depends on the thickness and profile of the sheeting and the presence or otherwise of a sealant in the joint but it shall not be more than 450 mm apart unless more stringent requirements are recommended by the cladding MANUFACTURER.
- e) All primary & secondary fasteners shall be provided with plastic cup washer of same colour as the cladding sheets, unless otherwise specified by the COMPANY.
- f) All roof joints shall be sealed, and no lap joints shall be less than 150 mm.

### 12.3 Crane Runways

- a) Crane runways and their supports shall be designed with the impact load values in accordance with COMPANY specification for Structural Design Basis.
- b) The crane runaway beams shall be rolled structural steel shapes or welded plate sections. The crane rails shall be in accordance with ASTM A759 or equivalent British Standards. The buffers and rails supplied by FABRICATOR shall be shop assembled or welded except otherwise noted on drawings.

## 13 INSPECTION & TESTING REQUIREMENTS

### 13.1 General

- a) CONTRACTOR is responsible to supply materials conforming to the applicable ASTM/ British standards, including all material certificates/testing. Mill reports covering chemical and physical properties for each type of steel shall be included. Materials heat number to be cross referenced and traceable with Mill test certification. Inspection certificate Type 3.1 (BS EN 10204 reference) shall be provided for COMPANY approval.
- b) Material mill test reports or certificates of compliance with ASTM and WPS/PQR reports fully identified with respect to the applicable part shall be maintained by the STEEL VENDOR for COMPANY's/CONTRACTOR's review and approval.
- c) The CONTRACTOR shall submit to the COMPANY a Certificate of Conformance, prior to shipment, verifying appropriate and relevant certified mill test reports, the materials supplied meet the applicable specifications.

- d) In addition to the test Certificates which will be submitted, COMPANY may request to have independent tests performed to inspect material prior to fabrication.
- e) CONTRACTOR shall maintain a testing program during fabrication and erection works. CONTRACTOR shall supply all certificates and test reports on any material when called for by COMPANY. The whole of the material shall be subject to inspection at all stages during fabrication and before dispatch from the work site of FABRICATOR/CONTRACTOR.
- f) All work laid out, assembled or erected may be required by COMPANY to check the accuracy of work to ensure is completed in accordance with the drawings and specifications.
- g) The SUBCONTRACTOR shall provide all inspection tools and shall provide inspection access facilities such as platforms, ladders, and scaffolds as requested by the CONTRACTOR/COMPANY inspector.
- h) Inspection tools and tool calibration record for tools used by the sub-contractor shall be maintained and available for examination by the CONTRACTOR/COMPANY inspector.
- i) An independent testing and inspection agency hired by the CONTRACTOR and must be approved by the COMPANY shall perform following activities:
  - 1) Inspection of high-strength bolted connections.
  - 2) Visual inspection of field welded connections.
  - 3) Any additional tests and inspections of field work that may be required by the COMPANY.
  - 4) Agency shall prepare test reports for the COMPANY's review.

### 13.2 Bolts, Nuts and Washers

- a) All fastener products shall be furnished with mill test certificates showing full conformance with applicable ASTM/ British standards.
- b) In addition to the proper mill test certificates furnished, minimum 3 nos. of bolts, nuts, washers' assemblies shall be tested from each mill heat and each manufacturing lot for each different MANUFACTURER's fasteners shall be taken from job site for testing by an independent test lab in accordance with applicable ASTM/ BS standard test procedures. At least three load indicator washers shall also be taken for each size and shall be tested in accordance with ASTM F 959.
- c) Lot traceability to material and to manufacturing Certified Material Test Reports is required for all high strength bolts and nuts.
- d) Certified mill test reports for each heat of structural steel and each lot of high-strength bolts shall be available for review and approval by COMPANY.

### 13.3 Welding

- a) Records of all data, test and examinations relating to welder qualifications and all welding procedures used during construction and erection shall be made available to the COMPANY.

- b) The quality of welds and inspection shall be in accordance with the requirements of AWS D1.1/D1.1M Code or AWS QC1.
- c) CONTRACTOR's inspectors shall be qualified and certified as AWS Certified Welding Inspectors in accordance with the provisions of AWS D1.1 or AWS QC1, or shall be trained by and working under the supervision of an AWS Certified Welding Inspector.
- d) CONTRACTOR shall visually inspect all completed welds. All Inspections, Procedures and acceptance criteria shall be in accordance with AWS D1.1/D1.1M.
- e) Visual examination for all categories of weld shall reveal no cracks. Non-contiguous weld shall not be permitted.
- f) Undercutting beyond the limits of AWS D1.1/D1.1M, surface porosity, and crack-like discontinuities shall be removed to sound metal and repaired.
- g) Weld profiles shall be in accordance with Figure 5.4 of AWS D1.1/D1.1M.
- h) Visual and Non-Destructive Testing (NDT).
  - 1) All Inspections, Acceptance Criteria, NDT procedures & Extent of testing shall be in accordance to AWS D1.1
  - 2) All welds visually inspected shall be acceptable if the criteria of Table 6.1 of AWS D1.1 are satisfied.
  - 3) NDE methods, acceptance criteria, and additional requirements shall be as follows and in accordance with AWS D1.1 and SNT-TC-1A:
    - i) Five percent (5%) of the total number of full penetration welds shall be radiographed or ultrasonically examined 100 percent (100%) of the entire length of the weld(s) selected.
    - ii) Five percent (5%) of the total number of fillet or partial penetration welds shall be magnetic particle examined 100 percent (100%) of the entire length of the weld(s) selected. If anywhere one weld line meets another weld line, that location shall be one of the selected.
    - iii) When a selected weld is rejected, two additional welds shall be subject to NDE at the FABRICATOR's expense. This procedure of examining two welds for every weld rejected shall continue until all welds examined are accepted. The replaced welds shall also be examined.
    - iv) Weld selected to satisfy this five percent (5%) requirements shall be selected by COMPANY's representative and shall represent a sample of each welder's work for each type of weld.
    - v) Non-destructive Examination (NDE) records shall be available for review by the COMPANY's representative. The COMPANY shall reserve the right to request any other method of NDE in the course of work or for any corrective work performed by the CONTRACTOR.

## 14 SUBCONTRACTORS/SUBVENDORS

- a) The CONTRACTOR/VENDOR shall assume unit responsibility and overall guarantee for the fabrication of structural steel and the items associated with the operation and maintenance of pressure vessels.
- b) The CONTRACTOR/VENDOR shall transmit all relevant purchase order documents including specifications to his SUBCONTRACTORS and SUBVENDORS.
- c) It is the CONTRACTOR's/VENDOR's responsibility to enforce all Purchase Order and Specification requirements on his SUBVENDORS and SUBCONTRACTORS.
- d) The CONTRACTOR/VENDOR shall submit all relevant SUBCONTRACTOR and SUBVENDOR drawings and engineering data to the COMPANY.
- e) The CONTRACTOR/VENDOR shall obtain and transmit all SUBCONTRACTORS and SUBVENDORS warranties to the COMPANY, in addition to the system warranty.
- f) All drawings and engineering data submitted to the COMPANY shall be in the English language, and in metric units.
- g) The Steel VENDOR and Vessel VENDOR shall submit engineering data for review and approval by the COMPANY as noted below.
  - 1) All documents shall be produced in electronic format in accordance with COMPANY documentation standards.
  - 2) All documents shall indicate that they have been checked prior to submittal.
- h) The Steel VENDOR and Vessel VENDOR shall not proceed with fabrication until notified by the CONTRACTOR.
- i) The steel VENDOR shall provide complete fabrication drawings, including Bill of Materials, Bolting List and Sub-assembly / Component Weights and Shipping List.
- j) The steel VENDOR shall provide complete erection drawings, including all required field welds.
- k) The vessel VENDOR shall provide drawings showing the details and locations of all clips and attachments, which are welded to the vessel.

## 15 HANDLING

### 15.1 Packaging and Shipping

- a) Preparation for shipment shall be in accordance with the CONTRACTOR/COMPANY instructions and as noted herein. The CONTRACTOR shall be solely responsible for the adequacy of the preparation for shipment provisions with respect to materials and application, and to provide material at the destination in ex works condition when handled by commercial carriers.
- b) The MANUFACTURER/SUPPLIER/CONTRACTOR shall ensure that all steel and its coatings are protected from any damage and atmospheric corrosion caused by handling, storage, or

shipping before receipt by the COMPANY. Structural steel members shall not be handled until paint has thoroughly dried. All bolts, washers and nuts shall be packaged and delivered in rigid (not cardboard), weatherproof containers.

- c) All machined, bright finished, or other critical surfaces shall be protected by preserving, wrapping, capping, plugging, blocking, covering, and/or other suitable methods to protect against corrosion, dust, moisture, abrasion, or any other damage that is detrimental to the appearance and/or function of the material. These surfaces must be protected for the duration of the transport and storage.
- d) Plated, bare metal, and painted surfaces must be protected from direct contact with wood or fibreboard using a durable non-hygroscopic material. Bare metal and plated surfaces must be properly and adequately preserved against corrosion and discoloration. Metal surfaces that are susceptible to corrosion should be finished, painted, or coated to provide permanent protection.
- e) The MANUFACTURER/SUPPLIER/CONTRACTOR shall ensure that adequate protection is provided for threads on sag rods and any other threaded components to prevent damage during shipping and handling.
- f) Steelwork shall be handled by methods and equipment that will not cause overstress, deformation of the steelwork or damage to protective coatings.
- g) Structural steel fabricated that creates containment for liquid or solids must have appropriate drainage to prevent collection of liquid or solids. Holes must be large enough not to get block by solids such as sedimentary materials.
- h) Preparation for shipment and packing will be subject to inspection and rejection by the COMPANY's representative. All costs occasioned by such rejection shall be to the account of the CONTRACTOR. After inspection, material shall be prepared for shipment.
- i) Material shall be packed, securely anchored, and skid mounted when required. Bracing, supports, and rigging connections shall be provided to prevent damage during transit, lifting, or unloading. All temporary bracing/supports shall be marked "REMOVE BEFORE EQUIPMENT COMMISSIONING AND STARTUP".
- j) Non-hygroscopic shock absorbing sheeting is required between all surfaces of items where abrasion protection is required.
- k) Open ends of tubes and pipe shall be capped for protection. Separate, loose, spare parts, small items and all bolts, washers shall be completely boxed or bagged.
- l) Tape may be used to secure plastic bags or plastic coverings only as temporary covers. Tape shall not leave adhesive residue on any surface after being removed.
- m) Exposed finished and machined surfaces, including bolting, shall be given a coating of rust inhibiting compound. Internal metal surfaces shall be sprayed or coated with a suitable rust preventative prior to shipment. Items shall be suitably tagged to indicate the rust preventative applied.

- n) All loose items shall be completely boxed or crated. All pieces shall be identified by item number and marked with COMPANY's Purchase Order number, tag number, and weight, both inside and outside of each individual box or crate. A shipping list shall be enclosed in each box or crate. Bolts and nuts shall be shipped assembled, in clearly marked containers, packed for each structure and colour coded to suit.
- o) All bolting material, including washers and nuts, required for erection (plus spares) shall be furnished and delivered with the first shipment of each steel release package.
- p) Delivery of steel shall be made in the order needed for erection. The delivery sequence for the fabricated steel, unless otherwise noted in the contract documents or arranged by CONTRACTOR, shall be as follows: Loose base plates, steel embedded in concrete, erection bolts, columns shall be shipped together with the connecting beams, bracing, connection cleats, bolts, fastenings, etc., In the case of multi-storey structures, the lower levels shall be shipped before the upper ones. Stairways, handrailing and flooring shall be shipped at the same time as the relevant structure.
- q) One complete set of the installation instructions and drawings shall be packed in the boxes or crates. This is in addition to the number called for in the Purchase Order. A bill of material shall be enclosed in each package or container of parts.
- r) Railcars and/or trucks shall be loaded and cribbed so that others can readily unload them. Items shall be loaded in such a manner that continuous drainage will occur.
- s) Unless otherwise required by the COMPANY, all materials shall be inspected by the CONTRACTOR immediately after receipt to ensure that the materials are not damaged, that all items on the packing list have been supplied, and that all documentation has been received. If any damage is discovered, or any parts, components, or documentation are missing or otherwise defective, the occurrence shall be immediately reported to the COMPANY in writing and damaged material shall be separated from undamaged materials.
- t) Any galvanizing or painting which becomes damaged shall be repaired in accordance with the COMPANY Specification for Painting and Galvanizing.

## 15.2 Preservation and Storage

- a) Materials shall be protected to withstand ocean transit and extended period of storage at the jobsite for a minimum period of 18 months. Material shall be protected to safeguard against all adverse environments, such as: humidity, moisture, rain, dust, dirt, sand, mud, salt air, salt spray, and sea water.
- b) All material shall be preserved, and export packed in accordance with COMPANY Specification for "Preservation and Export Packing".
- c) All materials designated for the care, custody, and control of the ERECTOR shall be received, unloaded, stored, and otherwise handled in a manner that prevents distortion, deterioration, damage, or staining. Material shall be kept free of dirt, grease, and other foreign matter.

- d) Store materials to permit easy access for inspection and to maintain identification. Keep steel members off the ground, using blocking or other means. Protect steel members and packaged material from corrosion and deterioration. Bolts shall be kept in dry storage.
- e) All materials used in construction shall be stored so that they are safe from damage by construction traffic or deterioration by exposure to weather. In areas where corrosive salts are present in the atmosphere near the ground, the steel components must be staked on supports at least one meter clear of the ground. Under no circumstances shall materials be stored directly on the ground.
- f) Non-hygroscopic shock absorbing sheeting is required between all surfaces of items / abrasion protection is required.
- g) All machined, bright finished, or other critical surfaces shall be protected by preserving, wrapping, capping, plugging, blocking, covering, and/or other suitable methods to protect against corrosion, dust, moisture, abrasion, or any other damage that is detrimental to the appearance and/or function of the structural steel and/or parts thereof. These surfaces must be protected for the duration of the transport and storage.
- h) Any damage and/or deterioration of structural steel and/or preservation must be highlighted and assessed. Where COMPANY/CONTRACTOR/FABRICATOR realises damage to material or preservation controls have been compromised in transport or storage, must highlight to relevant authority to decide what rectification is required and schedule time for said rectification work. Cost of rectification will be the responsibility of custodian.

## **16 MARKING AND EXPORT PACKING**

### **16.1 Marking**

All steelwork pieces shall be marked in accordance with the following marking procedures or another approved procedure to be confirmed or adapted by COMPANY/CONTRACTOR.

- a) Each piece of mill material shall be legibly marked with the fabrication mill order number, heat number, section size, length, and mill identification mark in accordance with ASTM A6/A6M or equivalent British Standards.
  - 1) The piece mark for structures shall consist of following four parts:
    - i) Part 1 - Structure tag number containing the plant unit number and the sequential number of the structure within the unit.
    - ii) Part 2 - FABRICATOR's shop detail sheet number which shall not be repeated for the same Purchase Order.
    - iii) Part 3 - Piece designation by letter(s) indicating B for beams, C for columns, G for girders, BR for braces, PL for plates, etc. plus a sequential number assigned by the MANUFACTURER.
    - iv) Part 4 - Framing level number assigned by the FABRICATOR (for multilevel structures only).

|          |               |               |               |               |
|----------|---------------|---------------|---------------|---------------|
| Example: | <u>Part 1</u> | <u>Part 2</u> | <u>Part 3</u> | <u>Part 4</u> |
|          | 9003          | 14            | B2            | 5             |

The above example indicates the second beam detailed on shop drawing 14, located on the fifth framing level in the third structure in Unit 90.

The entire piece mark must be shown on all structural steel delivered to the jobsite. The shop erection drawing needs to show only Parts 2 and 3 and the shop detail drawing need to show only Parts 3 and 4.

- 2) The piece mark for pipe supports shall consist of the following three parts:
- Part 1 - Pipe support tag number containing the plant unit number and the sequential number of the pipe support within the unit.
  - Parts 2 and 3 - Shall be the same as for structures.

|          |               |               |               |
|----------|---------------|---------------|---------------|
| Example: | <u>Part 1</u> | <u>Part 2</u> | <u>Part 3</u> |
|          | PA 9104       | 14            | B2            |

The above example indicates the second beam detailed on shop drawing 14, located in the fourth pipe support in Unit 91.

The entire piece mark must be shown on all pipe supports delivered to the jobsite. The shop erection drawings need only show Parts 2 and 3 and the shop detail drawing needs only show Part 3.

- 3) The piece mark for Vessels - Ladders and Platforms. After galvanizing, each assembly or separate shipping piece shall be tagged and marked as follows:
- Alight gauge stainless steel tag no smaller than 38mm x 75mm shall be securely wired to the item. The tag shall be embossed with figures at least 6 mm high.
  - In addition to the metal tag, the item shall be indelibly marked with figures at least 50 mm high unless limited by the size of the item to be marked.
  - The metal tag and indelible marks shall show the following information.
    - Vessel item number.
    - Erection or assembly mark number as indicated on the Steel VENDOR's erection and detail drawings.
    - The metal tags and indelible markings shall be located at the left-hand side of the piece as detailed.
  - All ladder cage hoops shall be indelibly marked as noted in above clause c.
  - The location of the mark shall be on the left-hand end of the piece, as detailed. On the erection diagram the mark shall be in the corresponding "in place" position.

- 4) Members shall be piece-marked using one of the following methods for each piece:
- i) Metal tags stamped with the mark number and seal welded to the member.
  - ii) Mark numbers steel-stencilled on the member.
  - iii) Mark number in bed of weld.
  - iv) Handrails and other minor steel assemblies - metal tags stamped with the mark number and wire-tagged to the assembly.
  - v) Mark number shall be at least 16mm high and shall be stamped or stencilled deep enough so that they will be legible after painting or galvanizing.

## 16.2 Export Packing

### 16.2.1 General Provisions

- a) Packing operations (bundling, casing, etc.) may only begin after fabrication acceptance.
- b) Maximum sizes for fabricated pieces shall be limited to the size which can be transported by truck.
- c) Packing lists reflecting what is shipped shall be furnished with each load in a waterproof package.
- d) Packing shall be separate for each unit and structure. Grouping of structures provided for several units is not allowed.
- e) Steel shall be shipped in erectable lots, i.e. beams, columns, bracings, etc... for the same structure, at the same time.
- f) A lot shall be deemed packed when all the material required for field erection has been packed. In particular bolts, and other fastening items shall be packed at the same time as the main material of the corresponding lot.
- g) Necessary bolts shall be always sent with the structural steel components.
- h) The specific identification of each package, including Purchase Order or Contract Number, shall be marked on the top and two opposite sides.
- i) For each package, the following shall be marked:
  - i) Dimensions.
  - ii) Net weight and gross weight to be confirmed by CONTRACTOR.
- j) The weight of a package shall not exceed 5t (except for some pieces which can be arranged in pairs) to be confirmed by CONTRACTOR.
- k) All members shall be carefully handled and cribbed to prevent damage to members and protective coatings.

### 16.2.2 Types of packages

#### a) Category 1 – Bundles

- 1) Bundles shall be used for packing of standard straight shapes and built up welded shapes.
- 2) This type of packing will be used for parts not likely to be subject to permanent distortion during handling operations.
- 3) Packages shall be homogeneous, and all parts shall be properly wedged against one another.
- 4) Placing of accessories between steel shape flanges is prohibited.
- 5) Material hooping shall be with steel shapes with cross section equal to or exceeding 100mm and 24mm diameter studs provided with lock nuts.

#### b) Category 2 – Crates

- 1) Crates shall be used for steel structures, or plates, walkways, railing components, cage components, etc., as a rule for all components likely to be subject to distortion during handling.
- 2) The material shall be fixed inside by means of wooden shims suiting the material shape.

#### c) Category 3 – Cases

- 1) Cases without internal liner:
  - i) They shall be used for packing of assembling components, not shop assembled in their final position on main parts, such as short angles, gussets, wedges, etc... These components shall previously be grouped in series per identical structure number and coated with the shop protection provided on main parts.
- 2) Cases with internal liner (waterproof):
  - i) They shall be used for bolting materials (bolts, nuts, washers) and welding electrodes.
  - ii) Bolt assemblies shall be properly oiled and placed in sacks prior to packing. Sacks shall be oiled prior to packing.
  - iii) Bagging shall be made per quality, length and diameter of bolts, including bolts, nuts and washers. A metal tag shall be affixed on each bag and another inside with the indication of the number, quality, diameter and length of bolts.

## 17 DOCUMENTATION

- a) The CONTRACTOR shall submit the type and quantity of drawings and documentation for COMPANY's authorization or information as listed in the individual Material Requisitions and Purchase Orders.
- b) The CONTRACTOR shall maintain a complete up-to-date set of erection drawings at the jobsite.
- c) Mutual agreement on scheduled submittal of drawings and engineering data shall be an integral part of any formal Purchase Order.

- d) Comments made by the COMPANY on drawing submittal shall not relieve the CONTRACTOR of any responsibility in meeting the requirements of the ADNOC General Specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.
- e) Each drawing shall be provided with a title block in the bottom right hand corner incorporating the following information:
  - 1) Official trade name of the company.
  - 2) CONTRACTOR's drawing number.
  - 3) Drawing title giving the description of contents whereby the drawing can be identified.
  - 4) A symbol or letter indicating the latest issue or revision.
  - 5) Purchase Order number and item tag numbers.
- f) Revisions to drawings shall be identified with symbols adjacent to the alterations, a brief description in tabular form of each revision shall be given, and if applicable, the authority and date of the revision shall be listed. The term "Latest Revision" shall not be used.
- g) The CONTRACTOR shall submit an "Affidavit of Compliance" before beginning fabrication. The affidavit shall confirm that all material meets the requirements of this Specification.
- h) The following documents shall be submitted to the COMPANY prior to the start of any fabrication and construction activities:
  - 1) Inspection and Test Plan (ITP).
  - 2) Inspection procedures document that provide details of compliance with the requirements in this Specification, the design drawings, shop and erection drawings.
  - 3) Test Procedure Qualification and Test Acceptance Criteria.
  - 4) Welding Procedure Specification (WPS).
  - 5) Associated weld procedure specifications covering all joint configurations.
  - 6) Welder(s) and Welder Inspector(s) qualification and certification records.
  - 7) Quality control program, quality plan, quality control procedure, including Quality Control Records (QCR's), records of quality inspection test reports, and test results.
  - 8) Procedure Qualification Record (PQR).
  - 9) Material Handling Procedure.
  - 10) Materials and workmanship specifications.
  - 11) One set of reproducible final erection and shop drawings.
  - 12) Maintain a complete to date (As Built) set of erection drawings at the jobsite.
  - 13) Method statements covering erection and construction methods, including temporary facilities (including scaffolding) and Health Safety Environment (HSE).
  - 14) Correction of non-conformances including repair procedures.
  - 15) Material Traceability Procedure.
  - 16) One set of engineering calculation for each type of the connection design.



## SECTION D

### **APPENDIX: 1    ADDITIONAL    SPECIFIC    REQUIREMENTS    -    SPECIFIC    TO    A    PARTICULAR APPLICATION OR BUSINESS UNIT (LIKE OFFSHORE OR PETROCHEMICAL)**

Not Applicable.

### **APPENDIX: 2    SPECIFIC LESSONS LEARNT**

Not Applicable.