# Ensuring Compliance of Structural Steelwork – Regardless of Origin

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## 1.0 Introduction

The globalisation of the structural steel supply chain has sparked concern over the quality of fabricated steelwork in New Zealand building projects when sourced from low-cost countries. Demonstrating compliance of imported material with the requirements of the New Zealand structural steel and welding standards can be very challenging: there are cultural, geographical and language barriers, and often a lack of independent quality assurance associated with offshore fabricator workshops.

This situation has placed greater onus on Construction Reviewers (typically Professional Engineers), as the technical expert relied upon by Building Control Authorities and clients to ensure steelwork for New Zealand building and infrastructure projects meets the requirements of the New Zealand Building Code.

The aim of this paper is help Construction Reviewers better understand their role and that of the fabrication company in achieving this end. It will also discuss international and local quality initiatives that will make the Construction Reviewer's role simpler and lower the risk of non-compliance to them. This risk is very real, in Australia there have been examples of Professional Engineers being sued for damages to cover the cost of expensive remedial work associated with non-compliant fabricated products from low cost economies (SCNZ 2014).

## 2.0 The New Zealand Building Code and Structural Steel Construction

### 2.1 Introduction

The Building Code sets out the performance requirements for building works. The relevant section which addresses the requirements for structural systems of buildings is B1. The Ultimate Limit State performance requirement for structures is as follows:

*Buildings, building elements and site work shall have a low probability of rupturing, becoming unstable, losing equilibrium, or collapsing during construction or alteration and throughout their lives.*

**Figure 1: Poorly fabricated steelwork – Glass barrier bridge truss (Australian project)**

This qualitative performance requirement is quantified using a probability-based design approach. In probability based design, the basis for most limit state standards such as AS/NZS 1170 (SAA/NZS 2002) and NZS 3404 (SNZ, 2007), the probability of failure is a base measure of structural reliability. To ensure an appropriate margin of safety, or low probability of failure over the life of a steel structure, reliability analyses have been undertaken. These reliability analyses use statistical data from element testing (e.g. beams, columns, welded connections, etc.) and material production data (e.g. yield strength) in conjunction with the allowable section geometry tolerances specified in structural steel manufacturing standards to establish the required values of the strength reduction factors ($\phi$) to enable the design capacity $R_d$ to be calculated.

Implicit in the standards calibration exercises are:

- Steel product mechanical and section geometrical properties fall within a certain range (eg coefficient of variation for structural steel yield strengths <10%).
- Structural steel components will be manufactured to specific standards (eg tolerances and permitted weld defects, etc).

## 2.2 Standards

There are various pathways to demonstrate compliance with the requirements of the Building Code. A commonly used route for the design and construction of structures is the use of standards cited in the Verification Method document VM/B1 (MBIE 2014). For structural steel structures, the cited standards include AS/NZS 1170 (Structural design actions) and NZS3404 (Steel Structures Standard).

NZS 3404.1 also references various secondary standards that are compatible for use with this document. This includes welding (AS/NZS 1554.1: SAA/NZS 2014), structural steel manufacturing (AS/NZS, EN, JIS, ASTM) and bolt manufacturing standards (AS/NZS 1252, SAA/NZS 1996).

If steel products outside those recognised in NZS 3404 are to be used, expert assessment is required to demonstrate these materials will not erode the margin of safety assumed in the reliability analyses used to establish the strength reduction factors in the standard.

NZS 3404.1:2009 and AS/NZS 1554.1 define the technical requirements for the manufacture of structural steel structures in New Zealand, which include:

1. Performance requirements (e.g. tolerances, acceptable weld defects, surface preparation).
2. Fabrication process limitations to avoid significantly degrading mechanical properties (holing, cutting, heat treatment, welding).
3. Means for ensuring/ demonstrating compliance with the requirements of the standard (acceptance of steels, material traceability, requirement for a weld quality management system, recommendations for weld inspection and testing regimes, mandating of a suitably qualified Construction Reviewer).

NZS 3404.1:2009 (SNZ 2009) includes specific requirements developed for New Zealand's seismic environment, which include:

- Material requirements (structural steel and welding consumables).
- Process limitations for the fabrication of yielding elements such as holing, surface roughness limitations for cut surfaces.
- Limitations on the welding of stiffeners in the K zone of hot rolled sections.

## 3.0 Roles and Responsibilities

### 3.1 Introduction

In steelmaking and structural steel construction, production controls and conformance assessment testing by the steel manufacturer and steel fabricator, in conjunction with construction monitoring by a suitably qualified third-party is necessary to ensure the structural steelwork meets the requirements of the Building Code. These roles, in particular, those of the Construction Reviewer and the Fabricator are discussed in detail in the following sections.

### 3.2 Construction Reviewer

The Building Act 2004 requires a suitably qualified person to verify that the construction complies with the Building Code. This is recognised in NZS 3404 with the requirement that construction of a structure to which the Standard is applied shall be adequately reviewed by a competent person, known as a Construction Reviewer.

The Construction Reviewer will typically be a Professional Engineer. They may be supported by a nominated representative such as a welding engineer or welding inspector. The Construction Reviewers role is important during the construction stage to ensure that:

- The design is being correctly interpreted.
- The construction techniques are appropriate and do not compromise the effectiveness of the design.
- The work is generally completed in accordance with the plans and specifications.

The extent of this construction monitoring is related to the complexity and consequence of collapse of the structure, and the status of the fabricator's quality assurance system. Recommendations on this are given in clause C1.8 NZS 3404.1:2009.

A construction reviewer for a steelwork project will typically:

- Review shop drawings.
- Address matters to be resolved for welded construction including approval of the welding procedures, see Appendix D AS/NZS 1554.1.
- Arrange for third-party weld and protective coating inspection and testing as required by the contract documents.
- Review fabricator execution documents (mill certificates, weld inspection reports etc.).
- Undertake site inspections of fabricated components in the workshop and on-site.
- Issue a producer statement PS4 at the completion of the project, stating all the building structure works, including the structural steelwork, is in accordance with the consent documents.

An important and often neglected task of the construction reviewer is to ensure that the fabricator is operating some form of manufacturing control system (procedures, personnel, inspection and testing) to ensure and demonstrate product conformity. The production documentation generated by the operation of this system in conjunction with any third-party inspection and testing undertaken by the engineer or their nominated representative, will provide good evidence that the fabricated product meets the requirements of the contract documents.

The ideal situation to reduce the Constructor Reviewer's risk, is if the fabricator's production control system is third-party certified by an appropriate conformance assessment body. If this is not the case, the Construction Reviewer, or their nominated representative should review the adequacy of the fabricator's production control system. An example of a fabricator certification scheme operating in New Zealand is discussed in Section 4.3.

There are additional challenges associated with fabrication offshore, particularly in low cost countries. Once the product has been paid for and shipped, it is very difficult to seek redress if it is subsequently found not to be to the required standard. In order to mitigate these risks the Construction Reviewer needs to have a presence in the fabricators workshop. This could either be a trusted third-party inspector acting on their behalf, or they spend time undertaking workshop inspections themselves. Care is required in selecting a third-party inspector, as locals in some low cost countries are reluctant or unwilling to fail non-conforming product for cultural reasons. Some suggested product conformity requirements for steelwork fabricated in low cost countries are outlined in Appendix A.

### 3.3 Fabrication Company

The Fabricator is the party with the primary responsibility for ensuring the structural steelwork is manufactured to the requirements of the contract documents. To do this they must operate some form of production control system, which will include:

1. A quality assurance system (procedures and personnel).
2. An inspection and test plan to ensure/ demonstrate work is to the required standard.

The following list, while not exhaustive, identifies some of the key elements of a fabricator production control system (ECCS 2012).

- Traceability and component marking.
- Weld quality management.
- Contract and technical review.
- Acceptance of materials (structural steels, weld consumables, bolts).
- Personnel.
- Subcontracting.
- Fabrication processes (milling, drilling, cambering, thermal and mechanical cutting, and protective coatings).
- Equipment (maintenance regime, inspections, calibration).
- Corrective measures for non-conformance.
- Documentation control.
- Inspection and testing.
- Production records.

For the sake of brevity, only the first two items in the list above are discussed in the article, the remaining items will be covered in a New Zealand Structural Steel Compliance Guide discussed in Section 4.4.

#### 3.3.1 Traceability and Component Marking

NZS 3404 requires that the grades of steel remain identifiable at all stages of fabrication and erection, or the steel should be classed as unidentified steel. Any marking of steelwork shall be such as to not damage the material.

The extent of traceability required is a function of the risk associated with the failure of components and should be nominated in the contract documents. The following is a description of the different levels of traceability.

#### Basic Traceability

The delivered material must be accompanied by test certificates to verify that the steel grade is correct. Once issued from stock into the manufacturing/fabrication system, the grade of steel shall remain identifiable by some form of marking, but individual plate and section components need not be traced back to the test certificate (for example, by the heat number).

**Full Traceability**

In addition to the requirements of basic traceability, the materials must be traceable at all stages to test certificates. This traceability may be based on records for batches of product allocated to a common production process, unless traceability for each product is required.

Basic traceability would be suitable for importance level 2 structures (AS/NZS 1170) subject to low seismic demand (category 3 and 4 seismic load resisting systems) or low level fatigue actions not requiring specific assessment. Full traceability should be considered for importance level 3 and 4 structures and the components of importance level 2 structures subject to high to medium seismic demand (category 1 and 2 seismic load resisting systems) or requiring specific fatigue assessment. Basic traceability would be suitable for secondary elements such as purlin cleats and brackets.

**Figure 2: An example of component marking in the fabricator’s workshop**

### 3.3.2 Welding

Welding is a so-called “special” process, which means that a complete verification of the welded joint is not possible without destroying it. Therefore, to ensure the proper quality of the welded product and to optimise manufacturing cost, the whole welding process must be controlled from the very start. For structural steel applications, this is achieved by applying a quality management system. AS/NZS 1554.1 (Structural Steel Welding Standard – Part 1: Welding of steel structures) states the quality management system should generally comply with the requirements of AS/NZS ISO 3834 (SAA/NZS 2008).

A key feature of this standard is the requirement to ensure that people with welding responsibilities are competent to discharge those responsibilities. This includes welding supervisors and welders.

AS/NZS ISO 3834 requires the fabricator to have written procedures and instructions to ensure they have control over the welding process and, as a consequence, welding is consistently undertaken to the required standard. This standard identifies the typical documentation required to demonstrate control over the welding activities. These procedures/ instructions cover such items as (ECCS 2012):

- Reviewing contract/technical requirements.
- Subcontracting.
- Qualification of procedures and personnel for welding and inspection.
- Storage and handling of consumables.
- Equipment maintenance/calibration.
- Production/inspection plans.
- Repair procedures.
- Traceability record.
- Documentation control.

Examples of weld production documentation are given in appendix B.

**Figure 3: Inspected and approved weld preparation**

## 4.0 International and Local Product Conformance Initiatives

### 4.1 Introduction

The globalisation of structural steel procurement has increased the compliance risk for all parties involved in this procurement process; construction reviewers, builders, building consent authorities and building owners. In response to this concern various international and local product conformity initiatives covering both structural steels and fabricated product have been undertaken (e.g. ISO/CD 17607). Those most relevant to a New Zealand context will be discuss in the following sections.

## 4.2 Third-party Product Certification

Reliable structural steel design is based on steels with dependable mechanical properties. The global nature of today's structural steel market means there is an increased need for appropriate product conformance requirements to ensure compliant material is used for structural steel projects. Accordingly, international best practice product conformance is moving away from first-party product conformance declaration (where the steel manufacturer tests its product and, provided it meets the particular manufacturing standard, self declares the steel to be compliant), to third-party certification such as the ACRS scheme.

The Australasian Certification Authority for Reinforcing and Structural Steels (ACRS) has become the first structural steel conformance assessment body (CAB) to be accredited by the Joint Accreditation System for Australia and New Zealand (JAS-ANZ) to certify mills producing structural steels to AS/NZS standards. This accreditation demonstrates the ACRS scheme is technically robust and impartial. Notably, there are two New Zealand representatives on the governing board of ACRS: Dr Stephen Hicks, HERA, and Nick Hill, Building Officials Institute NZ.

One of the strengths of the ACRS scheme is that, in addition to its regular audit of the manufacturer's quality management systems to assure product compliance, it also examines the end-to-end production process, production test data and independent verification testing. Furthermore, to assist specifiers, ACRS operates a policy of "All Products: All Locations" such that a manufacturer who is ACRS certified must be certified by ACRS for all the products they supply to AS/NZS standards, from all the locations they supply them from (e.g. all their business units), for all the standards for construction steels that ACRS certifies to.

Most of the steel mills supplying the New Zealand Structural market are among the ranks of ACRS certified companies manufacturing product to AS/NZS standards. This includes New Zealand Steel with parent company BlueScope, OneSteel, Tung Ho (Taiwan), Siam Yamato Steel (Thailand), Nippon Steel (Japan), and Hyundai Steel (South Korea). For the current certification status of each company, refer to the ACRS website.

For additional information about the ACRS scheme, visit www.steelconstruction.com

## 4.3 Steel Fabricator Certification Scheme (SFC)

### 4.3.1 Introduction

The Steel Fabricator Certification Scheme was launched in September 2014. Sixteen New Zealand fabrication companies representing over 65% of the New Zealand structural steel industry output are currently certified with several additional companies undergoing the audit process. This scheme was developed jointly by HERA and SCNZ and is implemented by an independent audit authority, HERA Certifications Ltd.

The Steel Fabricator Certification (SFC) scheme introduces a mark of quality to New Zealand's structural steel sector. It aims to reduce the compliance risk for engineers, builders, and building and infrastructure owners.

The SFC scheme provides independent expert third-party certification of New Zealand fabrication companies to ensure they have the appropriate personnel and procedures to consistently produce work of the required quality.

### 4.3.2 Scope

The scheme's focus is currently on structural steel fabrication; work is progressing in 2016 on extending the scheme to include erection and coatings.

Certification is only limited to the company's quality assurance system and should not be understood to include product certification.

### 4.3.3 Technical and Quality Requirements

The technical and quality requirements of the scheme are set out in the scheme Code of Practice. This is only an interim document until the joint Structural Steelwork Execution Standard AS/NZS 5131 is published (this standard follows international best practice which is reflected in the standards ISO/CD 17607 and EN 1090-2; both New Zealand and Australian representatives are currently participating on the committee for the former ISO standard, to ensure that the forthcoming AS/NZS 5131 is well aligned). The Code of Practice document is based on NZS 3404.1:2009 and AS/NZS 1554.1 with some enhanced quality assurance provisions for certain types of structures.

Utilising a risk based approach, four construction categories (CC1-4) are introduced for structural steel structures covering a wide range of applications. The technical and quality requirements become more onerous as the construction category increases. It is the role of the project Structural Engineer to specify the construction category for the structure or for elements of the structure.

It is anticipated that most structures will fall into construction category 2 or 3. CC1 applies to secondary structures typically not requiring a Building Consent and for which the consequence of failure would be low, such as a farm shed. CC4 only applies to railway bridges with fracture critical elements.

The principle differences between construction category 2 and category 3 requirements are that the material, weld procedure and welder traceability requirements are more onerous, as is the case for the weld quality management requirement. Certification to the Weld Quality Standard AS/NZS ISO 3834 is mandatory for CC3.

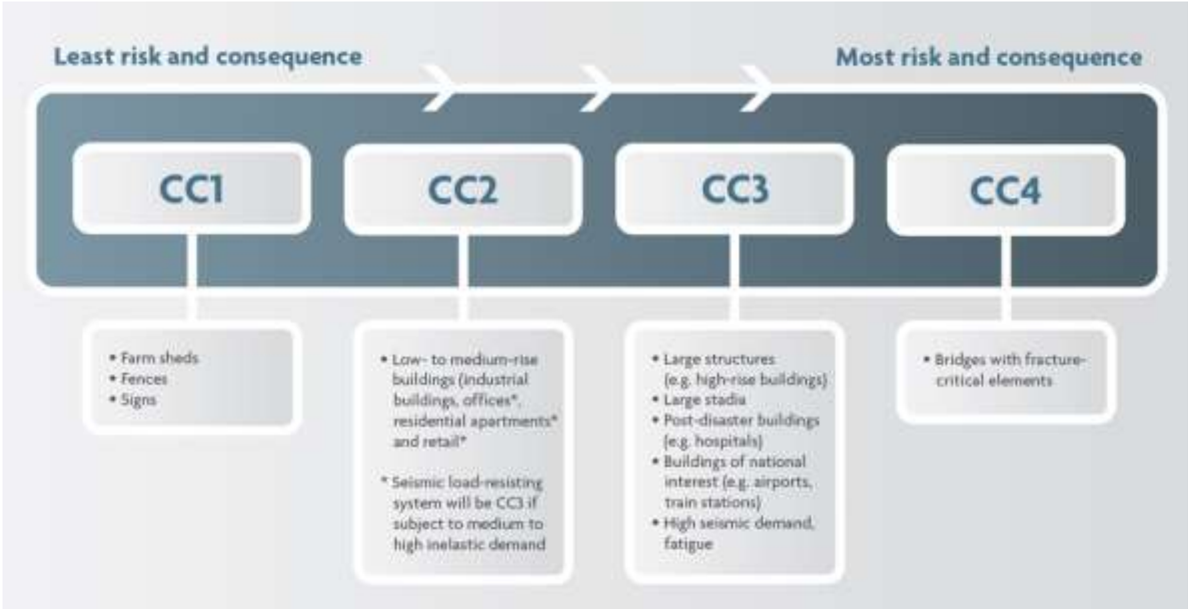


**Figure 4: SFC construction categories**

### 4.3.4 Independent Auditing Authority

An independent auditing body, HERA Certifications Ltd, has been established to audit and certify steel fabrication companies; it will audit both the welding and the fabrication quality management systems. They have been accredited by the International Institute of Welding (IIW) as an Authorised National Body for Company Certification (ANBCC). As a consequence, HERA Certifications Ltd is able to certify fabrication companies to the internationally recognised Manufacturer Certification Scheme IIW ISO 3834 in addition to certifying fabricators to an SFC construction category for their overall fabrication quality assurance system.

A governance structure has been established for the audit company. The governance board currently consists of the representatives from HERA, SCNZ and industry. The governance board representation will be broadened with the addition of a professional engineer and a building official in 2016.

### 4.3.5 How it works

**Fabricator**

Steel fabricators must demonstrate to an independent auditing body that they have appropriate systems in place to control the critical fabrication processes, which includes materials, traceability and welding. Fabricators are certified to a construction category from CC1 to CC4 and are able to work on projects within or below the category they are certified for. Certification is valid for five years but fabricators must undergo annual surveillance audits to maintain their SFC status.

**Structural Engineer**

The designer specifies a Construction Category for the structural steelwork, either as a whole or for various components. While SFC certification will reduce the compliance risk for the Construction Reviewer, there is still an important role for them to independently verify the work is carried out in accordance with the contract documents as certification does not extend to product certification. This role is discussed in more detail in Section 3.2.

**Builder**
Builders must ensure that the fabricators they engage for steelwork contracts are certified for the appropriate Construction Category specified by the designer. Certified fabricators will display an SFC quality mark so procurers and specifiers can easily identify firms that meet the required standards.

For more details on the scheme including a list of certified fabricators visit www.steelfabcert.co.nz.

### 4.4 Structural Steelwork Compliance Guidelines

#### 4.4.1 Introduction

With the advent of imported fabricated structural steelwork for New Zealand building and infrastructure projects, HERA and SCNZ have been asked to assist Building Control Authorities, Structural Engineers and Building Regulators address the compliance issues associated with these projects featuring imported products.

While many of the same issues apply to ensuring and demonstrating compliance of structural steelwork, regardless of origin, there are additional challenges that need to be understood and addressed when structural steelwork is sourced internationally. A consideration often associated with imported fabricated steelwork, is the use of alternative steels not recognised in the steel structures standard.

In response to these requests, HERA and SCNZ have initiated a Compliance Project. The outcome of this project will be the publishing of a two part Structural Steelwork Compliance Guideline document. Part 1 will cover the use of alternative steels while the second part will cover ensuring and demonstrating the compliance of structural steelwork, particularly welded fabrication. The aim is to have the project complete, or well advanced by the end of 2016. An industry working group of practicing engineers and regulators will be convened to inform and review the development of the Guidelines.

This project will pull together and extend compliance guidance previously prepared by industry. These include the following documents:

- What you need to know if considering importing seismic resisting fabricated steel structures (www.hera.org.nz).
- Checklist for imported structural steelwork version 1_4 December 2015 (www.scnz.org).

#### 4.4.2 Project Status

The priority item for the compliance project is to establish guidelines for the use of alternative materials in conjunction with NZS 3404. According to NZS 3404.1:2009, the use of such steels requires expert assessment to demonstrate that the alternative steel is equivalent to one of those listed in NZS 3404. This process falls outside the scope of NZS 3404 as a verification method. This requirement is ambiguous as it does not clarify in what respect the alternative steel is equivalent to a recognised steel. The mandating of a qualified materials engineer or metallurgist implies the exercise involves demonstrating chemical and mechanical equivalence, but fails to clearly state that there are also structural reliability aspects that need consideration.

The University of Western Sydney has been commissioned to undertake structural reliability analyses to evaluate the capacity factors ($\phi$) for a range of international structural steel making standards and a range of coefficient of variation for the yield strength for use with NZS 3404. In addition, where limited data is available to reliably establish the coefficient of variation, the researchers will also consider the impact of this limitation on the capacity factor ($\phi$). This reliability exercise will consider composite and non-composite elements subject to both flexural and axial loading.

Based on this research, a simple methodology will be developed utilising mill yield strength production data to determine if the NZS 3404 capacity factors $\phi$ are appropriate for steel manufactured to standards not recognised in the Steel Structures Standard. Implicit in the standards calibration exercise undertaken for AS 4100 (which forms the basis for NZS 3404), is a maximum yield strength coefficient of variation of 10%. If the steel mill does not have adequate factory production control to limit its coefficient of variation to this value, or there is insufficient production data available for a particular product, the capacity factor $\phi$ must be reduced. In effect, this down-rates the capacity of structural steel elements designed using these steels to ensure margins of safety are not eroded. Capacity factors for a range of coefficients will be presented.

In the interim, until this guidance on alternative steels is published, structural engineers or building consent authority officials can contact HERA or SCNZ for technical support on this matter.

## 5.0 Conclusions

Construction Reviewers play an important role in the New Zealand building code control system. They are the technical experts relied on by Building Control Authorities and clients to verify compliance of construction works. This role has become increasingly important with the advent of global procurement of structural steel for New Zealand building and infrastructure projects.

In such an environment, Construction Reviewers need to carefully consider the scope of their service and any requirement to engage third-party experts to assist them in fulfilling their role responsibly and without undue risk. This will include the Construction Reviewer or their nominated representative spending time in the overseas fabricator’s workshop. Local experience to date has shown there is considerably more time required to provide Construction Review services for imported steelwork projects, this needs to be reflected in the service engagement agreements with clients.

The implementation of a fabricator production control system in conjunction with third-party inspection and testing undertaken in the fabricator’s workshop is essential to ensure and establish the steelwork is to the required standard. It is very difficult after the fact to establish the compliance of product once it arrives on site without destructive testing of welds and materials, which is costly and can lead to programme delays.

Internationally and locally there has been various structural steel quality initiatives to reduce the compliance risk to all parties associated with procurement of structural steel. In addition New Zealand specific compliance guidelines are in the process of being developed with the aim of empowering Construction Reviewers to more competently and confidently fulfil their important role for projects featuring structural steel, regardless of the origin of the product.

## References

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CEN, Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures, EN 1090-2: 2008+A1: 2011, European Committee for Standardization, Brussels, Belgium, 2008

## Appendix A – Suggested Product Conformance Requirements for Structural Steel Fabrication in Low Cost Countries

### A.1 Fabricated Product

### A1.1 Fabricator Production Control System

The fabricator must operate some form of quality assurance system. This could be in the form of a third-party certified quality assurance system, or one that has not been formally audited and certified.

The Construction Reviewer has a role to play in ensuring the quality system in place is appropriate to control the key manufacturing processes, which includes:

Third-party certified system

- Review the credentials of the conformance assessment body (to ensure that the conformance assessment body is certified in the required area of expertise).
- Check the certificate is current.
- Check the scope of the certification. The key elements identified in Section 3.3 and the Weld Quality standard AS/NZS ISO 3834 should be covered in the quality assurance system. Note ISO 9001 certification may be inadequate if the scope of the system certification does not cover the key elements required for controlling welded fabrication, as noted above.

Non third-party certified quality assurance system

- Review the scope and appropriateness of the quality assurance system.

### A1.2 In-shop Construction Monitoring

The Construction Reviewer or their trusted nominated representative should be resident in the fabricators workshop for the duration of the fabrication works. This may not require the person to be present in the shop all the time, however they must be on-site for the critical activities, such as observing weld preparation or surface preparation for painting where it will be impossible after the fact to check if the work was prepared to the required standard. In this role they should, but not limited to, undertake the following:

- Review the adequacy of the quality assurance system (Appendix A1.1).
- Ensure the fabricator is operating their quality assurance system.
- Inspect fabrication at critical hold points, particularly welding operations and surface preparation prior to coating.
- Review personnel competency including welding supervisor, welders, coating supervisors.
- Review welder qualifications, ensure weld procedures have been qualified and are being used.
- Approve fabricator's weld procedures and address other matters to be resolved issues (Appendix D AS/NZS 1554.1).
- Oversee third-party weld and material testing to ensure competently undertaken and reliably reported in test reports.

- Check fabricated components to the required standard (dimensions, surface finish free from significant notches and gouges from fabrication processes and material defects, etc.).

### A.2 Structural Products

The product conformity requirements for accepting structural steels manufactured in low cost countries to alternative standards not recognised in NZS 3404, will be dependent on the factory production control (FPC) system (quality assurance system) of the steel mill. The following guidance is based on a Singapore Building Control Authority document (BCA 2012). The other issues associated with the use of alternative steels are discussed in Section 4.4.2.

The acceptance criteria for steels mills with a third-party certified FPC system is a valid FPC certificate from a suitably competent conformance assessment body and a mill certificate or test report meeting the requirements of NZS 3404.1:2009 clause 2.2.2.

If the mill does not operate a third-party certified FPC, the product should undergo 100% visual inspection by a suitably qualified person to ensure that the product is dimensionally within tolerance and free from significant defects due to manufacturing processes. Each batch of product used for the project should also be independently tested for mechanical properties and chemical composition at a trusted test facility. Ideally, some, or all, of this should be undertaken in New Zealand. This is the current practice of at least one government agency for structural steel from certain low cost countries. Care must be taken to ensure the tested material is traceable to a heat of steel for product used in the project. The test report or certificate should also meet the requirements of NZS 3404.1:2009.

# Appendix B – Examples of Weld Production Documentation

## Table 1: Weld traceability record

WELDING QA CHECK REPORT

| | | | |
|---|---|---|---|
| **Fabricator:** | SFC Certified Fabricator Ltd | | |
| **Project:** | Event Centre | **Construction Code:** | NZS3404.1 |
| **Job No:** | 111222xx | **Acceptance Criteria:** | AS 1554.1 SP 2014 |
| **Date:** | 25/06/2015 | **Purchase Order No:** | 45681xx |

| Drawing No | Description | WPS No | Weld No | Weld Type | Welder ID | Fabrication Check [ID] | Internal Visual Check [ID] | Test Standard | External NDT | | | | | Report No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | RT | UT | MT | PT | Visual | |
| 136 | Base Plate | 56 | 40 | FW | TH | RP | BC | 15541.1 | | | X | | X | 15-025-05 |
| 136 | Beam to beam Flange welds | 64 | 41 | BW | TH | RP | BC | 15541.1 | | X | | | X | 15-025-07 |
| 138 | Beam to beam Flange welds | 64 | 42 | BW | JD | RP | BC | 15541.1 | | | | | | |
| A-121 | Gusset and Cleat | 56 | 43 | FW | JD | RP | BC | 15541.1 | | | | | | |
| A-126 | Splice Plates | 56 | 44 | FW | TH | RP | BC | 15541.1 | | | | | | |
| A-126 | Base Plate | 56 | 45 | FW | CB | RP | BC | 15541.1 | | | | | | |
| A-126 | Gusset and Cleat | 56 | 46 | FW | JD | RP | BC | 15541.1 | | | | | | |
| A-129 | Beam to beam Flange welds | 64 | 47 | BW | CB | RP | BC | 15541.1 | | X | | | X | 15-025-08 |
| A-129 | Base Plate | 56 | 48 | FW | CB | RP | BC | 15541.1 | | | X | | X | 15-025-09 |
| 139 | Splice Plates | 56 | 49 | FW | CB | RP | BC | 15541.1 | | | | | | |
| 201X | Beam to beam Flange welds | 64 | 50 | BW | TH | RP | BC | 15541.1 | | X | | | X | 15-025-10 |
| 201X | Plate and end cap | 56 | 51 | FW | JD | RP | BC | 15541.1 | | | | | | |

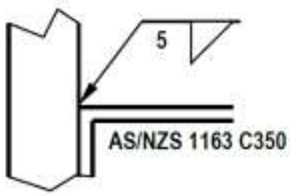
Name: ____________ Date: ____________ Signature: ____________

## Table 2: Weld procedure specification

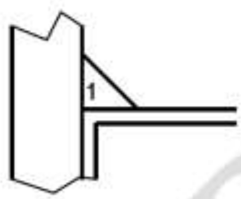
| WELDING PROCEDURE SPECIFICATION | | | |
|---|---|---|---|
| Material spec/grade | AS/NZS 1163 C350 To AS/NZS 3679.1 G300 | | |
| Fabricator | **Example Engineering Ltd.** | WPS no. | **EE2** |
| Standard | **AS/NZS 1554.1:2014** | Date | **2.3.15** |
| Process | **FCAW** | PQR No | **EG2** |
| Edge preparation | **Square** | Page | **1 of 1** |
| Welding direction | NA | Revision | **0** Date **NA** |
| Range qualified | **Fillet weld ≤ 5mm leg length**<br>**Combined thickness ≤ 36mm** | Positions | **1F, 2F, 4F** |
| Preheat temperature | NA | PWHT | NA |
| Method and check method | NA | | |
| Inter-run temperature (max.) | NA | | |

**Joint sketch**

**AS/NZS 3679.1 G300**




**Run sequence**




| Joint tolerance | |
|---|---|
| Prequal. Joint no. | **F1** |
| To Table | **E3** |
| Root gap G mm | **+ 1.5mm** |
| Root face $F_r$ mm | NA |
| Incl.angle θ° | NA |
| Backing | NA |

| WELDING CONSUMABLES | | | | |
|---|---|---|---|---|
| Specification - Root | **AS/NZS ISO 17632** | | | Flux<br>NA |
| Classification - Root | **B-T493U** | | | |
| Shielding gas | **$CO_2$** | Flow rate | **15 –17 l/min** | |
| Purge gas | NA | Flow rate | NA | |

| Weld run details | | | | | Welding parameters | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No. | Side | Position | ϕ mm | Tradename | Amps | Voltage | Current And polarity | Speed mm/min | Heat Input KJ/mm |
| **1** | **1** | **1F, 2F, 4F** | **1.2** | **Wunda-Core** | **240-260** | **27-29** | **DCEP** | **250-330** | **1.2-1.8** |
| | | | | | | | | | |

| | | | |
|---|---|---|---|
| Technique | | **Stringer**/weave | |
| Single-run or multi-run | **Single** | Electrical stick-out | **20-25 mm** |
| Initial cleaning | NA | Backgouge | NA |
| Inter-run cleaning | NA | Gouge check | NA |
| Notes/revisions<br>1. NA – Not Applicable | | | |
| Approved by<br>*A. Lincoln*<br>AS 2214 Welding Supervisor | | | |