



BRANZ
APPRAISAL
CERTIFICATE
No. 385 (2000)

This Certificate replaces
BRANZ Appraisal Certificate
No. 385 (1999)

THREE DEE
CONSTRUCTION
SYSTEM

Marketed by:
Three Dee Engineering Ltd
PO Box 29-191
Greenwoods Corner
Auckland
Tel: 0-9-424 3418
Fax: 0-9-424 4354
email: threedeng@hotmail.com

Readers are advised to check that this Certificate has not been amended, withdrawn or superseded by a later issue. Refer to the "Valid Certificates Index" in BUILD magazine published by BRANZ, the Certificate Listing on the BRANZ Internet Site, or contact BRANZ.

BRANZ, Private Bag 50908
Porirua City
New Zealand
Telephone: +64-4-235 7600
Fax: +64-4-235 6070
<http://www.branz.org.nz>



Product

- *This Certificate relates to the Three Dee Construction System, which is a polystyrene core and reinforced concrete wall, floor and roof panel system for buildings.*
- *The system has been appraised for use as load-bearing and non-load bearing walls, and for floor and roof panels in the construction of specifically designed buildings. Fire-and sound-rated walls may also be constructed using the system.*
- *Engineering and architectural design, installation and construction is carried out only by Three Dee Engineering Ltd, or under their supervision and quality control, in accordance with the details contained within its Design and Installation Manual, dated August 1999, and referenced throughout this Certificate as the 'technical literature'.*
- *Design of structures must be undertaken in accordance with the Three Dee Design Manual Guidelines, which are incorporated in the technical literature and referenced throughout this Certificate as the 'design guidelines'.*



Three Dee Concrete House

Building Regulations

1. New Zealand Building Code (NZBC)

In the opinion of BRANZ, the Three Dee Construction System if used, installed and maintained in accordance with the statements and conditions of this Certificate, will meet or contribute to meeting the following provisions of the NZBC:

Clause B1 STRUCTURE: Performance B1.3.1, B1.3.2 and B1.3.4 for the relevant physical conditions of B1.3.3. See section 5.

Clause B2 DURABILITY: Performance B2.3.1(a), not less than 50 years. See Section 6.

Clause C3 SPREAD OF FIRE: Performance C3.3.2, C3.3.4, and C3.3.5. See Section 8.

Clause E2 EXTERNAL MOISTURE: Performance E2.3.2 and E2.3.6. See Section 10.

Clause E3 INTERNAL MOISTURE: Performance E3.3.1. See Section 11.

Clause F2 HAZARDOUS BUILDING MATERIALS: Performance F2.3.1. The system will not present a health hazard to people.

Clause G6 AIRBORNE AND IMPACT SOUND: Performance G6.3.1. See Section 12.

Clause H1 ENERGY EFFICIENCY: Performance H1.3.1 and H1.3.2. See Section 13.

Product Information

2. General

2.1 The Three Dee Construction System consists of panels manufactured to form a three-dimensional truss-type welded-wire space frame integrated with an EPS (expanded polystyrene) core. The panels are placed in position, and wythes of concrete from 45 - 80 mm thickness are applied to both sides (see Figure 1).

2.2 Panels are butt-jointed, with extra layers of welded-wire fabric spliced over the joints, around openings and at internal and external corners. Reinforcing ties and bars are used at building element junctions to add strength to joints.

2.3 The panels are produced in a standard width of 1200 mm, with lengths supplied as required up to 6000 mm. The panels weigh approximately 6 kg/m², and may be site cut to size and shape. The standard EPS core thicknesses are 40, 50, 80 and 100 mm. The welded-wire fabric has a standard size of 50 x 50 mm mesh x 2.8 mm wire diameter. Larger wire gauges and mesh spacings are also available.

3. Handling and Storage

3.1 If it is necessary to store panels on site by stacking, care must be taken to ensure they are stacked flat, and that they are kept clean and undamaged. The panels may need to be weighted or tied down during storage in windy conditions.

3.2 Long-term storage of the panels must be carried out in a covered, protected, dry environment, so that corrosion of the reinforcing does not occur and the panels do not get damaged.

Design Information

4. General

4.1 The Three Dee Construction System is used in buildings that have been specifically designed in accordance with NZS 3101 and NZS 4203 using the design guidelines.

4.2 The Three Dee Construction System is used to provide the required bracing resistance for earthquake and wind loads.

4.3 Foundations are to a specific design in accordance with NZS 3101 and NZS 4203 using the design guidelines, and floors are usually concrete slab-on-ground.

4.4 Roof framing and interior partitions may be constructed using conventional details as set out in NZS 3604, or may be to a specific engineering design, as an alternative to using Three Dee panels. Steel framing, or pre-cast concrete units such as beams or panels may also be used, but must be to a specific engineering design. Roof trusses, if used, must comply with Clause 10.2.2 of NZS 3604. Roof coverings can be conventional and must meet the requirements of the NZBC, e.g., Section 11 of NZS 3604 and Paragraph 1.0 of NZBC Acceptable Solution E2/AS1. Where the Three Dee panels are used for roofing, a roof cladding system complying with the NZBC must be installed over the panels.

4.5 A concrete floor topping slab must be placed over floor panels to form upper level floors.

4.6 Exterior concrete may be painted or finished with cement-based plaster and weatherproofed, or any other proprietary weatherproof finish system suitable for use over concrete or cement-based plaster (see Section 17).

4.7 Interior finishing is carried out by either applying a coat of interior plaster or fixing any other lining system to the concrete.

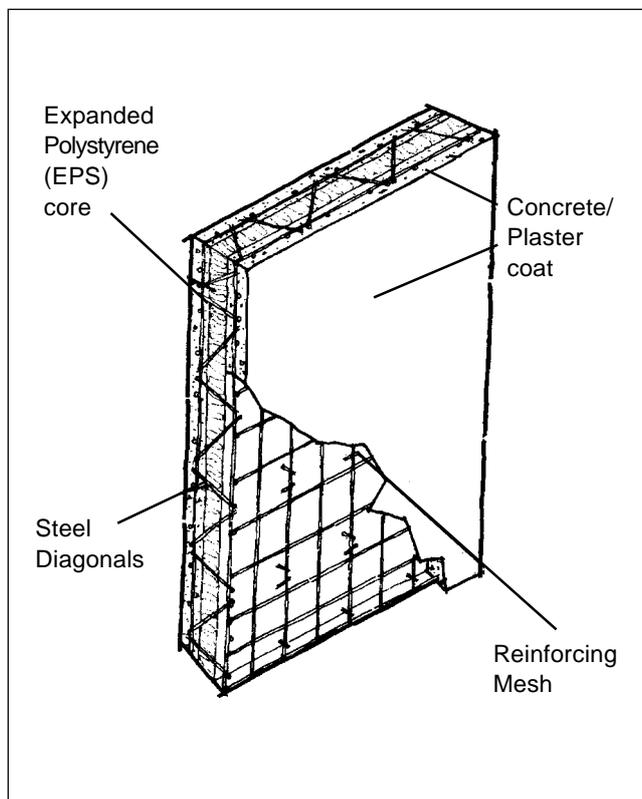


Figure 1

5. Structure

5.1 The Three Dee Construction System panel receives its out of plane strength and rigidity by truss action where the concrete wythes are the chord members and the diagonal cross-wires are the web members.

5.2 The design of the Three Dee Construction System follows the requirements of NZS 3101. Design guidelines and requirements are set out in the technical literature, and must be followed at all times. The design guidelines cover loading, design requirements and material properties, durability, flexure, axial load, in-plane shear, and standard details.

Impact Resistance

5.3 The Three Dee Construction System provides a robust system that has a high resistance to hard and soft body impacts likely to be associated with normal residential use situations.

6. Durability

6.1 NZS 3101 Section 5 specifies exposure zones, concrete strengths and cover requirements for the New Zealand environment. As the Three Dee Construction System is intended for use throughout New Zealand, a number of situations will apply.

6.2 The design guidelines set out in Section 4 the durability requirements that must be met for the Three Dee System, and in Table 4 summarises the requirements of Tables 5.1 and 5.5 of NZS 3101 for exposure zones, minimum cover and concrete strengths that apply to this system (see Table 1 of this Certificate).

6.3 Reliance should not be placed on the external applied coatings for protection of the reinforcing against corrosion. The concrete must give this protection.

Table 1: Minimum Cover Requirements

Exposure Environment Classification		Minimum Required Cover for Various Concrete Strengths, f'c (MPa)		
		20	25	30
A1	Interior surfaces, or surfaces in ground contact protected by a damp proof membrane	25	25	20
A2	Above ground exterior surfaces in inland areas, or surfaces in ground contact in non-aggressive soils	40	35	30
B1	Interior surfaces subjected to repeated wetting and drying, or exterior surfaces in coastal areas	50	40	35
B2	Exterior surfaces in coastal frontage areas	-	50	45

Notes to Table 1:

1. The extent of Inland (A2) and Coastal Perimeter (B1) zones are shown in Figures 5.1(a) to (f) in NZS 3101.
2. The Coastal Frontage zone (B2) is defined typically as within 100 m of the high tide mark, or 500 m of the high tide mark to the direction of a prevailing or other common wind. Specific assistance for New Zealand's main regions are given in Table 5.2 of NZS 3101.
3. The “-” for classification B2 at 20 MPa indicates that this is not permitted by NZS 3101.

Maintenance

6.4 Annual checks of the building exterior must be made to ensure the entire building envelope remains weatherproof in accordance with the performance provisions of NZBC Clause E2. Moisture must not penetrate the structure and cause corrosion of the reinforcement.

7. Outbreak of Fire

7.1 Separation distances from flues for the Three Dee Construction System are not required in accordance with the requirements of C1/AS1 for the protection of the material.

7.2 However, care must be taken to protect heat sensitive lining and finishing materials where they are used, and where penetrations are made in the panels for flues and the like to pass, the EPS core material must be protected. Protection and separation methods as set out in NZS 7421 and NZBC Acceptable Solution C1/AS1 may be used for compliance.

8. Spread of Fire

8.1 The Three Dee Construction System can be used for load-bearing and non-load bearing walls to provide passive fire and smoke protection. Fire resistance ratings (FRR) of up to 120/120/120 can be achieved with the system. Construction details are contained in the technical literature and must be strictly followed to obtain the required fire resistance rating.

8.2 There are no fire resistance rating requirements for single unit detached housing up to two storeys (NZBC Fire Purpose Group SH) built more than 1 m from a boundary. Where less than 1 m from a boundary, or for buildings in other purpose groups, the fire requirements are given in NZBC Acceptable Solution C3/AS1.

9. Structural Stability During Fire

In order to satisfy the requirements of NZBC C4 Structural Stability During Fire, designers must ensure that the fire-rated elements are supported by building elements having at least the same fire resistance rating as the element they are supporting.

10. External Moisture

10.1 A roof cladding system complying with the NZBC must be installed and maintained, and the exterior walls must be protected with a weatherproof coating system.

10.2 Concrete slab-on-ground floors must be protected by a damp-proof membrane.

10.3 Exterior joinery complying with the NZBC must be installed to openings in exterior walls. Exterior moisture must be excluded by detailing joinery and wall joint interface as shown in the technical literature, or designers may detail their own details, for which they alone must accept responsibility for compliance with NZBC Clause E2 and B2.

10.4 When using detailing as set out in the technical literature, designers must still check that the detail will meet their own design requirements, and the requirements of NZBC Clause E2 when these details are incorporated into their particular design. Compliance with NZBC Clause E2 is dependent on the correct incorporation of these details into the building design.

10.5 When designers use their own details, these are outside the scope of the Certificate.

10.6 The details given in the technical literature are based on the use of head, jamb and sill flashings. Reliance must not be placed on sealants alone in order to achieve weathersealing at openings. Sealants must be used only as a rain screen in conjunction with a suitable flashing system.

10.7 Roof cladding systems, exterior joinery, and exterior and interior finishes have not been assessed for compliance with the NZBC and are outside the scope of this Certificate, unless they have been BRANZ appraised as suitable for this particular use.

Table 2: Fire Resistance Ratings As Tested To BS 476:1987

Three Dee Panel thickness: (concrete EPS/ concrete)	Partition Type	Period partition satisfied performance criteria (minutes)		
		Load Bearing Capacity (minutes)	Integrity (minutes)	Insulation (minutes)
38/50/38	Non-load bearing	N/A	90	90
75/80/75	Load bearing	125	125	125

11. Internal Moisture

11.1 Internal moisture control for Housing constructed using the Three Dee Construction System can be met by compliance with E3/AS1. Minimum thermal ratings of R1.5 must be provided for walls, ceilings or roofs, and ventilation must be installed to comply with G4/AS1. (Note: wall and roof panels will require additional insulation to achieve the R1.5 rating.)

11.2 Alternatively, designers can use the wall R-value of R1.4 (using 100 mm polystyrene core panels) and incorporate into the building the following features as an alternative solution which will meet the E3 performance provision:

For buildings erected in all Climate Zones as defined in NZS 4218:

- The floor and roof of the building insulated to the minimum level required by NZS 4218, calculation method.

Three Dee Panel thickness: (concrete/EPS/ concrete)	Additional insulation	Typical Application	STC Rating
40/100/40	9.5 mm plasterboard on resilient channels on timber battens, with 50 mm sound absorbing blanket, to one side.	Suspended floor, internal or external wall.	55
40/100/40	12.5 mm plasterboard on resilient channels on timber battens, with 50 mm sound absorbing blanket, to one side.	Suspended floor, or external wall.	57
70/50/45	Nil	External wall.	45
45/50/45	Nil	Internal or external wall.	44
45/50/45	9.5 mm plasterboard on resilient channels on timber battens, with 50 mm sound absorbing blanket, to both sides.	Internal or party wall.	59
45/50/45	12.5 mm plasterboard on resilient channels on timber battens, with 50 mm sound absorbing blanket, to both sides.	Internal or party wall.	61

Notes:

1. Sound absorbing fibreglass or mineral fibre blanket bulk density in the range 12-60 kg/m³.
2. Battens at 600 mm centres and no less than 45 mm thickness.
3. Channels of 0.5 mm metal thickness and 13 mm deep fixed horizontally.
4. Gypsum plasterboard of no less than 680 kg/m³ bulk density.
5. Concrete density to be no less than 2000 kg/m³.

- At least 10 openable windows (Note: compliance with NZBC G4 Ventilation must also be met).
- An extractor fan or range hood in the kitchen, and an extractor fan in all bathrooms.

Additional for buildings erected in Climate Zone 3 only:

- Permanent heating of at least 500 W for each bedroom, or at least 4.6kW of permanent heating to the house.

11.3 Appropriate moisture control measures, such as internal vapour barriers or permanent ventilation, should be employed where internal moisture is above normal levels, such as could be expected in saunas, spa pool rooms, swimming pool rooms and the like which may be incorporated into buildings.

12. Airborne Sound

The Three Dee Construction System can be used for walls that are common between occupancies, and therefore required to meet a minimum Sound Transmission Class (STC) of 55. To meet this requirement, the walls must be constructed in accordance with the sound insulation details contained in the technical literature and Table 3 of this Certificate.

13. Energy Efficiency

13.1 The Three Dee Construction System can be used in Housing applications to meet the thermal insulation requirements of NZS 4218. Thermal insulation design which conforms with NZS 4218 will meet the performance provision of NZBC H1.3.1. Other means of meeting the provision of H1.3.1 are listed in H1/VM1.1.

13.2 In all Climate Zones of NZS 4218, the schedule method can not be used unless additional insulation to meet the minimum R-values is added to the system. Specific design can, however, be undertaken using the calculation method of NZS 4218 and the R-values for the system given in Table 4 of this Certificate.

13.3 Procedures for meeting the requirements of NZBC H1 for buildings other than Housing are indicated in H1/

VM1.2, using NZS 4220 as a guidance document.

13.4 The approximate thermal resistance rating (R-value) of the Three Dee Construction System panels, including minimum concrete thicknesses required, but excluding exterior or interior coatings or linings, are as set out in Table 4 of this Certificate.

Table 4: Panel R-values

Panel Polystyrene Core Thickness (mm)	Approximate R-value (m ² °C/W)
50	0.8
80	1.2
100	1.4

13.5 The above R-values are based on standard panels using mild steel diagonal cross-wires. Ratings can be increased by approximately 50% if panels with stainless steel diagonal cross-wires are used, because of the lower thermal conductivity of these wires which bridge the insulation core. These panels are available upon request from Three Dee Engineering Ltd.

Installation Information

14. Panels

14.1 Installation must be carried out in accordance with the technical literature. It contains, in particular, details on the correct sequence for the erection of the panels.

14.2 Wall panels must be erected vertically, starting at corners and working along. Connections between the panels and the foundation or floor must be made by means of starter bars that have been cast or set into the foundation or floor and wired to the welded-wire fabric. Panels must be

plumbed and temporarily supported as erection takes place. Final adjustment of supports for correct alignment can be carried out when all panels are erected.

14.3 Panels can be cut to shape and size, or openings formed in them by cutting with a power saw, or using bolt cutters on the welded-wire fabric and a sharp blade, hand saw or hot wire on the EPS.

14.4 All joints in the panels must be connected by means of a splice mesh to create a continuous reinforcing mesh over the wall. Splice mesh must also be fitted at external corners, internal corners, and around openings at window and door reveals. A 'butterfly' of mesh should also be placed on a 45° angle across the corner of all openings.

14.5 Once all ground floor wall panels have been erected and braced, floor slab panels (where applicable) are placed over the top of the walls. Temporary support must be provided to floor panels by means of beams and props. Connections can then be made between the floor and wall panels when final alignment of the wall panels has been completed. Reinforcing bars required to the floor panels should be fixed in place before the panels are lifted. Reinforcing bars and splice mesh must be fitted at joints and connections, as required by the particular building structural engineering design.

14.6 The upper wall panels (if applicable) must be installed as for the ground floor wall panels, and roof panels (if applicable) must be installed similar to floor panels. Any built-in hold-down or fixing devices required must be attached in the correct positions before concreting commences.

15. Services

15.1 Services may be run concealed within the panels by installing them behind the welded-wire fabric. If insufficient space exists between the welded-wire fabric and the polystyrene, the polystyrene may be cut away sufficiently to form a chase for the service.

15.2 PVC sheathed electrical cables must not come into contact with the EPS and must, therefore, be contained within a conduit or be laid without conduits away from the EPS.

15.3 Where services penetrate external panels, the penetration must be made weathertight on the outside. Clearance for services movement must be made in accordance with the service element providers' specifications.

16. Concrete Installation

16.1 All concreting work must be carried out in accordance with NZS 3109 with regard to workmanship and materials.

16.2 Concrete is sprayed onto walls, ceilings and roofs using a shotcrete pump, and is pumped in place for floor topping slabs. Upper level floor topping slabs are usually placed before internal walls and ceilings to upper levels, and allowed to cure, to give a working platform for spraying the interior.

16.3 Some supports may be removed from under slabs after 3 days, but critical supports, such as those at mid-span, must be left in place until the slab is fully cured. The structural engineering design must provide the appropriate details for supports and sequence and timing of removal of them.

16.4 Concrete must be of the correct strength and mix design as required by the structural engineering design.

16.5 The normal procedure is to apply the concrete in two layers, although the application may be carried out in one single coat. The first layer is applied to a thickness to just cover the welded-wire fabric, and the second layer to give the final required thickness. The first layer is usually left to cure for a few days to provide initial load transfer to the panels. Any supports or stiffeners that have been attached to the panels are

removed before the second layer is sprayed, and the gaps left by the supports are in-filled with sprayed concrete.

16.6 The first layer of concrete is left 'rough' to give adequate key to the second layer. Correct concrete thickness must be measured as work proceeds. Screed points of concrete may be used as gauges to give correct concrete thickness and lines. Hand trowel finishing of the second layer is required to give the appropriate finish and surface tolerances. The ability to provide concrete finishes to the tolerances required by the designer or NZS 3109, is entirely dependent on the skill and workmanship of the concrete finishers.

16.7 Curing of the concrete must be carried out as set out in NZS 3101, and requires a minimum curing period of 7 days for external concrete and 3 days for internal concrete. Generally, this will require the concrete to be kept damp by applying water to the surface. This may be carried out by means of a fine spray hose or wet screms placed over the surface.

16.8 Conventional roof construction (where applicable) can be installed once all walls and floors have been erected and concrete work completed.

17. Finishing

17.1 After joinery installation has been completed using the detailing as set out in the technical literature, the exterior and interior finishes can be applied to the concrete surfaces.

17.2 Interior surfaces (walls and ceilings) are finished with a thin coat interior plaster applied in accordance with the technical literature. Alternatively, any other suitable lining system may be used, providing it is installed in accordance with the lining manufacturers' instructions.

17.3 Exterior finishes may be any weatherproof coating system recommended by the coating manufacturer as suitable for use on concrete or cement-based plaster, or other BRANZ Appraised systems suitable for this purpose. Plaster finish coats in accordance with NZS 4251 may also be used externally over the concrete, providing the weatherproof coating is also installed.

17.4 Exterior and interior finishing systems are not covered by this Certificate, unless they have been BRANZ Appraised as suitable for this use.

Basis of Appraisal

The following is a summary of the technical investigations undertaken.

18. Tests

18.1 Fire resistance tests have been carried out by:

- SISIR (Singapore Institute of Standards and Industrial Research) in accordance with BS 476:Part 22 to determine the fire resistance of a non-load bearing element of construction.
- SIRIM (Standards and Industrial Research Institute of Malaysia), in accordance with BS 476: Part 21 to determine the fire resistance of a load-bearing element of construction.

18.2 A sound insulation test has been carried out by the Testing and Research Institute of the Municipality of Vienna. The test report has been reviewed for BRANZ by Marshall Day Associates, consultants in acoustics, and found to be satisfactory.

19. Other Investigations

19.1 The following documents have been reviewed by BRANZ and found to be satisfactory:

- The Three Dee Design Manual Guidelines and sample calculations produced by Three Dee Engineering Ltd's

structural engineers, dated December 1998.

- The technical literature, including installation instructions and detail drawings, titled 'Design and Installation Manual Three Dee Construction System', dated August 1999.

19.2 The manufacture of the Three Dee Construction System panels has not been examined by BRANZ, but details of the quality and composition of the materials used were obtained and found to be satisfactory. The manufacture of the panels is carried out by the Three Dee Agent in Malaysia, under a quality control system approved by the Three Dee Patent Holder.

19.3 Site inspections were carried out by BRANZ to assess methods used for the installation of the Three Dee Construction System and to examine completed installations.

19.4 Opinions have been given by BRANZ technical experts covering structure, durability, outbreak of fire, spread of fire, structural stability during fire, internal moisture and energy efficiency.

20. Sources of Information

- BS 476:Part 21:1987 Methods for the determination of the fire resistance of loadbearing elements of construction.
- BS 476:Part 22:1987 Methods for the determination of the fire resistance of non-loadbearing elements of construction.
- New Zealand Building Code Handbook and Approved Documents, Building Industry Authority, 1992.
- NZS 3101:1995 Concrete structures standard.
- NZS 3109:1997 Concrete construction.
- NZS 3604:1999 Timber framed buildings.
- NZS 4203:1992 Code of practice for general structural design and design loading for buildings.
- NZS 4218:1996 Energy efficiency-Housing and small building envelope.
- NZS 4220:Code of practice for energy conservation in non-residential buildings.
- NZS 4251:Part1:1998 Solid plastering-Cement plasters for walls, ceilings and soffits.
- NZS 7421:1990 Specification for installation of solid fuel burning domestic appliances.
- The Building Regulations 1992 including September 1997 Amendment.



Three Dee Construction Detail



Three Dee Parapet Detail

In the opinion of BRANZ, the Three Dee Construction System is fit for purpose and can be used to meet the relevant provisions of the NZBC provided it is used, installed and maintained as set out in this Certificate.

This Certificate is issued only to the Certificate Holder Three Dee Engineering Ltd and is valid until further notice, subject to the Conditions of Certification.

Conditions of Certification

1. This Certificate relates only to the product as described herein.
2. The Certificate Holder continues to have the product reviewed by BRANZ and abides by the BRANZ Appraisals Services Terms and Conditions.
3. The product and the manufacture are maintained at or above the standards, levels and quality assessed and found satisfactory by BRANZ.
4. This Certificate must be read, considered and used in full together with the manufacturer's/marketer's technical literature as appropriate.
5. BRANZ makes no representation as to the nature of individual examples of, batches of, or individual installations of the product, including methods and workmanship.
6. Where reference is made in this Certificate to any Regulation, Code, Standard, manufacturer's instruction or similar publication, it shall be construed as reference to such publication in the form in which it was in force at the date of this Certificate or as covered by Amendment to this Certificate.
7. This Certificate does not address any Legislation, Regulations, Codes or Standards, not specifically named herein.

For BRANZ



R I Burnett



M E Reed

Date of issue: 26 May 2000

©COPYRIGHT No part of this publication may be reproduced without the prior written permission of BRANZ.