



September 8, 2004

Mr. Joseph Cheng<sup>1</sup>  
PSB Corporation  
1 Science Park Drive  
Singapore 118221

RE: ASTM E 119 – ALTERNATIVE TEST OF PROTECTION FOR  
STRUCTURAL STEEL COLUMNS

Dear Mr. Lim,

This letter is in response to a request by Mr. John Schwartz of Contego International, Inc.<sup>2</sup> It is our understanding that the British standards are specified on a project in Singapore and that the ASTM International standards are unfamiliar to Singapore authorities.

### *Scope of the Evaluation*

It is Omega Point Laboratories' (OPL) understanding that Contego International requests an explanation of ASTM E 119 – ALTERNATIVE TEST OF PROTECTION FOR STRUCTURAL STEEL COLUMNS. Further, it is requested that we explain the rationale for allowing temperature, rather than failure under a superimposed load, to be the limiting criteria when testing columns.

Contego International is an OPL testing client but not an OPL Listing and Follow-up Service client, which means we do not have any Listings for Contego's Latex Intumescent contained in our *Directory of Listed Building Products, Materials and Assemblies*. Therefore, this letter is not to be used as justification for any other opinion or used for any other project, without the express written consent of Omega Point Laboratories. This letter will serve as Omega Point Laboratories' opinion comparing the two standards based on steel column testing. It does not address specifics of the product, including traceability of test samples and installation, or actual test data generated.

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### ***Information Reviewed for Evaluation***

The following documents were used for this evaluation:

- ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*
- *The SFPE Handbook of Fire Protection Engineering*, 2<sup>nd</sup> Edition
- The American Institute for Steel Construction – *Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings*.
- American Institute of Steel Construction, *Manual of Steel Construction – Allowable Stress Design*, Ninth Edition

### ***Comparing Test Requirements***

*Introduction* – The mechanical properties of steel are largely unaffected by heating operations provided that the maximum temperature does not exceed 1100° F, for quenched and tempered alloy steels, and 1300° F. for other steels.<sup>3</sup> ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, outlines the procedures of fire testing of structural elements located inside a building and exposed to fire within the compartment or room in which they are located. The temperature criterion used requires that the average of the temperature readings not exceed 1000°F for columns. An individual thermocouple's temperature reading on the steel protected by an insulation coating may not exceed 1200°F for columns. Test Method E 119 is a complete stand-alone document that includes all of the provisions of the individual parts of BS 476 referenced above. The key element of this discussion of ASTM E 119 is as follows:

***Load*** – BS 476-21 Section 6 (*Determination of the fire resistance of columns*) states that the column shall be tested under load. ASTM E 119 offers two alternatives when testing columns. One is to expose the column to fire on all sides throughout the fire endurance test, and load it with a superimposed load to simulate a maximum load condition. This load shall be the maximum load condition allowed under nationally recognized structural design criteria unless limited design criteria are specified and a corresponding reduced load is applied. A provision for transmitting the load to the exposed portion of the column should be made without increasing the effective column length. The other alternative is a test procedure that is used to evaluate the protection of steel columns without application of design load, provided that the protection material is not required by design to function structurally in resisting loads. The test specimen is exposed throughout the fire endurance test to fire on all sides for its full length. The test is regarded as successful if the transmission of heat through the protection during the period of fire exposure for which classification is desired does not raise the average (arithmetical) temperature of the steel at any one of the four levels above 1000°F (538°C), and does not raise the temperature

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<sup>3</sup> *Manual of Steel Construction – Allowable Stress Design* Ninth Edition



above 1200°F (649°C) at any one of the measured points. The protected steel temperature rises are conservative in terms of steel's loss of strength at elevated temperatures. Normally, testing to these temperature limitations would be considered a worst-case test scenario when compared to testing under a superimposed load other than the ultimate load of the column. **Under OPL Project No. 16539-114323 the columns protected by Contego's Latex Intumescent were fire tested using the temperature failure criteria for columns under ASTM E 119. The columns were not tested using a superimposed load representing a maximum design load.**

*The SFPE Handbook of Fire Protection Engineering* devotes an entire section to *Analytical Methods for Determining Fire Resistance of Steel Members*. ASTM E 119 employs an analytical method using the structural steel temperature rise as the limiting criteria. In doing so the three basic aspects of fire resistance are considered: fire exposure, heat transfer and structural response. It should be noted that *the endpoint temperatures of ASTM E 119 are selected according to conservative estimates of the maximum allowable reduction in load bearing capacity of the structural member, based on an average reduction in strength due to elevated temperatures*<sup>4</sup>. This conservative approach is usually more onerous than testing under a superimposed load. This presumption is supported by ASTM E 119's (BS 476) more liberal allowance when testing under a superimposed load.

*Throughout the fire endurance test, expose the column to fire on all sides and load it with a superimposed load to simulate a maximum load condition. This load shall be the maximum load condition allowed under nationally recognized structural design criteria unless limited design criteria are specified and a corresponding reduced load is applied. Make provision for transmitting the load to the exposed portion of the column without increasing the effective column length. Regard the test as successful if the column sustains the applied load during the fire endurance test for a period equal to that for which classification is desired.*

The modulus of elasticity of structural steel is approximately 29,000 ksi at 70°F. It decreases linearly to about 25,000 ksi at 900°F, and then begins to drop at an increasing rate at higher temperatures. The yield strength of A36 steel at 1000°F (538°C) is approximately 60% of its value at ambient room temperature. The maximum design stress is normally limited to 60% of the yield strength.<sup>5</sup> Therefore, the applied stress is approximately the same as the strength of the member's maximum permissible design stress at 1000°F (538°C), which is the limiting temperature rise of ASTM E 119 for steel columns at its fire-resistance rating period. Hence, the two provisions of ASTM E 119 (limiting temperature rise and testing a column with superimposed load) appear equivalent. It should also be noted that changes to the crystalline structure of steel occur at elevated temperatures. However, these changes usually occur at temperatures in excess of 1100°F to 1200°F (600°C to 650°C), which are above the limiting average temperature rise of ASTM

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<sup>4</sup> *The SFPE Handbook of Fire Protection Engineering* 2<sup>nd</sup> Edition

<sup>5</sup> According to *Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings*.



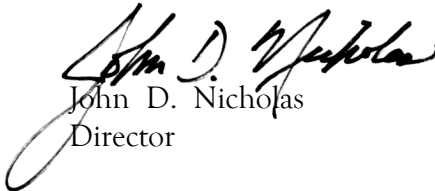
E 119 for steel columns at its fire-resistance rating period. Therefore, the crystalline structure of steel is not typically a factor when testing using the temperature limitation of ASTM E 119.

*Based on the information contained and referenced herein, it is Omega Point Laboratories' professional judgment based on sound engineering principles that the following is true:*

- *The ASTM E 119 requirements for testing a steel column based on temperature rise without a superimposed load are equivalent to the BS 476:20 and BS 476:21 for steel columns tested under a superimposed load.*

Should you need anything further or have any questions or comments, please call us at (800) 966-5253.

Sincerely,



John D. Nicholas  
Director

cc: John Schwartz, Contego International  
Deggary N. Priest, President (OPL)

