VIBRATION STUDY RESULTS

Cablofil Wire Cable Tray

Montbard Plant

From: J.C. Launay
Mgr., O.S.Q. - Nuclear Suitability
- Resonance Fatigue Strength

Re: Cablofil Vibration Tests

Date: 12/10/8?
Your Ref.:
Our Ref. JCL/CB

To:
M. Durin
Product Chief

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1 - Purpose of Tests

Cablofil is often installed on machines that generate substantial vibrations. It seemed desirable for us to fix the limits of our product regarding this utilization, especially since in the nuclear field, our cable path is required to withstand 2 or 3 g of acceleration for 30 to 45 seconds at a frequency of 15 Hz. These tests should make it possible to support the sales arguments of our sales department in negotiations of this type.

2 - Means Employed, Samples

2.1. - After some modifications, we use the vibration test assembly developed for the electrical construction department.

This assembly, which has a single degree of freedom (to simplify calculations), is comprised of:

a) a table: made of aluminum plate resting on 8 springs, guided by 8 self-aligning ball bushings to prevent interference due to non-perpendicular drive unit movement.

b) drive: provided by a cam adjustable from 0 to 4 mm, driven by a variable-speed DC motor with a range of 0 to 3600 RPMs that makes it possible to attain a frequency at the table ranging from 0 to 60Hz and acceleration of between 0 to 58 g.

c) measurements: a “pilot” accelerometer is attached directly to the table. Through an integrator, it allows for precise measurement of the level of acceleration imparted by the drive unit. One of its outputs is connected to one track of the oscilloscope to ensure that the movement transmitted is sinusoidal.

- 4 miniature accelerometers connected to a rack (which permits selection of the measuring tracks) are attached to the structure to be tested and allow for measurement of transmitted acceleration and displacement.
- a stroboscope is used to observe warping or buckling.
- the second oscilloscope track is used to display the structure’s resonance peaks.

2.2 - Samples

The sample elements to be tested are taken from available inventory. Length of tested plates: 1,100 m. Actual length subject to vibrations: 990 mm.
For the nuclear suitability tests (y : 2 and 3 g; f: 15 Hz, t :45 sec.) an element of each model and of each type of coating is tested.
For the resonance strength tests, only rough-cast plates are tested.

3 - Methodology

3.1 - Nuclear suitability test

a) attachment: the elements are carefully attached to the table by means of ST scale pieces (fastenings tightened with a torque wrench: 4 mkg for all elements).

b) settings: the cam is set in accordance with the following equation:

$$\mathbf{yg = w^2a}$$

in which: g = acceleration in cm/sec
w = angular frequency ($2\pi f$) in radian/second
a = amplitude in cm

which gives, for 2 g at 15 Hz:
a = 0.22 cm
for 3 g at 15 Hz
a = 0.33 cm

- The frequency is gradually adjusted to 15 Hz.
- The acceleration obtained is verified on the integrator of the pilot accelerometer.
- The test is continued for 45 sec.

3.2. - Resonance fatigue strength test

a) attachment: as for the nuclear suitability tests.

b) settings: 0 to 50 Hz sweeping with an arbitrary displacement a to determine the most significant resonance frequency, reading of this frequency, calculation of a to obtain an acceleration that we have fixed at 3 g; this frequency is maintained for a maximum of 15 minutes.

4 - Results

4.1. - Nuclear suitability test

No abnormal condition was noted either at the welds, or in terms of any pulling away of the coating, on any of the elements subjected to this test (15 in all).
For the TR series, the test was extended to 2 minutes (maximum imposed by the mechanical constraints of our system). We made the same observations.

4.2. - Resonance strength test

g = 29.5 m/sec²

Type	Fro Hz	Type	Fro Hz	Type	Fro Hz
TL 100	>50	T 100	> 50	TR 100	>50
TL 200	>50	T 200	>50	TR 200	>50
TL 300	41.2	T 300	41.4	TR 300	42.5
TL 400	42.8	T 400	43.1	TR 400	44.7
TL 500	46.1	T 500	47.8	TR 500	49.1

Equation: $fn = fro \times \frac{1}{2}\pi \sqrt{\frac{k}{m}}$

fn: Natural frequency: in Hz
fro: resonance frequency: in Hz
k: coefficient of stiffness in Newtons
m: weight of test structure = in kg
Peak-to-peak amplitude measured at the center of the elements during the test: (on the outside wings)

Type	a mm	Type	a mm	Type	a mm
TL 300	16	T 300	13	TR 300	10
TL 400	12	T 400	11	TR 400	9
TL 500	10	T 500	8	TR 500	5

Since the 100 and 200 mm-wide elements have a resonance frequency greater than our testing capabilities, it is clearly evident that we have not been able to carry out this measurement.
The maximum test duration was deliberately set at 15' in order to limit overheating of the mechanical system, which could lead to interference harmful to operation.
No abnormal condition was found following these tests.
At no point did we find any rupture of the welded cross-pieces even in the most stressed areas.

CABLOFIL INC
INNOVATORS IN CABLE MANAGEMENT

8319 State Route 4
Mascoutah, IL 62258 USA
Phone: 618-566-3230 or 800-658-4641
Fax: 618-566-3250
www.cablofil.com