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OPERATING PROCEDURES - FLAME TESTS ON RIGID DUCTS USED FOR MINE VENTILATION

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N.K. Sarin*

ABSTRACT

Flammability tests are carried out on a variety of flexible and rigid duct materials used for mine ventilation in order to evaluate their fire-resistance and their suitability in a mining environment. Several tests are available for this purpose, however, CEAL has been using CSA standard C22.2 No. 30 for at least 10 years as part of its program for certification of various mining products. An interim large scale gallery test has been introduced since July, 1985 in order to determine if better repeatability of test results can be obtained.

The aim is to eliminate threats to health and safety resulting from the use of such products in the mines. Special attention has been given to the safety precautions and sequence of operations necessary while conducting tests. A standard test recording sheet and test layout diagrams are also presented.

KEYWORDS: Ventilation, fire-resistance, flames, materials, testing, procedures, standards, certification, mines, safety, Canadian Standards Association (CSA), Mine Safety and Health Administration in the U.S. (MSHA), Canadian Explosives Atmospheres Laboratory (CEAL).

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MODES OPÉRATOIRES - ESSAIS À LA FLAMME SUR DES CONDUITS AÉRAULIQUES RIGIDES DESTINÉS À LA VENTILATION DES MINES

par

N.K. Sarin*

RÉSUMÉ

Des essais à la flamme ont été réalisés sur une gamme de matériaux rigides et souples utilisés pour fabriquer les conduits aérauliques des mines, en vue d'évaluer leur résistance au feu et de déterminer s'il peuvent être utilisés dans un environnement minier. Il existe plusieurs essais pour ce genre de contrôle. Toutefois, dans le cadre de son programme d'homologation de divers produits servant à l'exploitation minière, LRAE utilise la norme C22.2 n° 30 de l'ACNOR depuis au moins dix ans. Un essai provisoire sur grande échelle a été mené dans une galerie pour la première fois en juillet 1985. Il visait à déterminer s'il est possible d'améliorer les méthodes de façon à répéter les résultats lors des essais.

Le but de cet essai est d'éliminer les risques à la santé et à la sécurité que pose l'utilisation de ces produits dans les mines. Une attention particulière a été accordée aux mesures de sécurité et au déroulement des opérations au cours des essais. Un papier d'enregistrement ordinaire et des diagrammes illustrant le mode opératoire de l'essai font également l'objet d'une présentation.

Mots-clé : Ventilation, résistance au feu, flammes, matériaux, essais, méthodes, normes, homologation, mines, sécurité, Association canadienne de normalisation (ACNOR), Mine Safety and Health Administration in the U.S. (MSHA), Laboratoire de recherche sur les atmosphères explosives (LRAE).

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INTRODUCTION

Ventilation products are generally made from plastic materials reinforced with either textile fibres or fibreglass. Due to the inherent nature of plastic materials, they tend to be flammable unless special fire-retardant ingredients are mixed with the total composition at the point of manufacture.

Plastic materials also generate toxic gases when subjected to combustion for whatever reason. At present, emphasis is placed on controlling the flammability of the products rather than toxicity of products of combustion resulting from the flame tests. Precautions are considered necessary to prevent fires in mines by regulating and monitoring the use of such materials. Therefore, at the request of the Provincial Regulatory Authorities in Canada, CEAL has been providing testing and certification services on cost-recovery basis for the past 10 years.

Several standard procedures are available for both rigid and flexible duct materials. Some small scale tests have proven rather unreliable with shrinkable plastic materials. Therefore, large scale tests with better repeatability of test results are likely to replace the small scale tests. A single national standard is expected to emerge from the deliberations of the CSA committee on ventilation products. This committee is composed of representatives of the users, manufacturers, regulatory bodies and CSA staff.

In the past, CSA standard C22.2 No. 30 has been used for evaluation of fire-resistance in rigid duct materials. It is replaced by an interim large scale test based on the MSHA practice in the U.S., introduced since July, 1985. However, some improvements are necessary particularly with respect to control on ventilation velocities and standardization of the size and intensity of the ignition flame.

LARGE SCALE GALLERY TEST

A. Summary:

A sample of ventilation tube cut to 1200 mm (48") is suspended in a horizontal position inside an enclosed gallery and the flame is applied with methane gas through a special multiple jet burner on one end for 60 seconds. Continuous burning times are recorded after removing the ignition source, under both ventilated and still air conditions. A separate sample is used in each case.

B. Equipment:

1. A sheet metal gallery approximately 2 m square cross-section X 6 m long with scrubber system for treating toxic exhaust gases.
2. Impinged jet burner Solar Flow type U-10, #640 jets with a long stem and a quick disconnect nipple for gas line connection.
3. A positive ventilation flow system to give a maximum of 1.5 m/sec air velocity in the longitudinal direction.
4. Methane cylinder (commercial grade) with pressure gauge to 20 psig.
5. A digital anemometer to measure the air flow.
6. Gas masks.
7. Fire resistant tube with quick disconnect ends for fuel supply.
8. Ignition lighter with a long stem (approximately 900 mm).
9. A digital stop watch accurate to 0.1 seconds.
10. Micrometer to measure wall thickness of the tube.
11. A thermometer.
12. Fire-resistant gloves.
13. A 15 pound fire extinguisher.
14. Stainless steel wire.
15. A 24" (600 mm) steel ruler.

C. Test Conditions:

1. Average ventilation velocity: 0 or 1.5 m/sec.
2. Ambient temperature: 20° ± 5°C.
3. Flame length: 12 inches (30.5 cm).
4. Rate of gas consumption: Not specified. #
5. Gas pressure rating: Not specified. #

These parameters will be used later to standardise the size and intensity of the ignition flame.

D. Operations:

The following sequence of operations is recommended:

1. Prepare two samples of ventilation tubing preferably 400 mm (16") in diameter or whatever is available closest to this dimension X 1200 mm (48") in length. All flared or thickened ends of the tubes must be removed before testing.

2. Measure wall thickness of the tubing at four random spots using a micrometer and record the average reading.

3. Suspend one sample of the tube with a steel wire running through the inside of the tube and hooked to the ceiling at two places. The orientation of the tube should be horizontal and aligned parallel with the longitudinal direction of the gallery. The bottom level of the tube should be kept 100 mm (4 inches) above the top of the burner placed on floor level. Please refer to Figure 1.

4. Turn on the ventilation fan and close the gallery access doors before recording ventilation velocity at the top, middle, and the bottom levels of the tube. Ensure that the

average ventilation velocity measured in the longitudinal direction does not exceed 1.5 m/sec. Also ensure that the velocimeter is in good working order before using.

5. Take a temperature reading in the gallery with the thermometer and record the same.

6. Connect the burner to the methane fuel line suspended from the ceiling.

7. Open the gallery entrance door and light the burner with an ignition torch (having an extra long arm) while the other operator turns on the methane gas supply. Adjust the methane flow rate and the supply pressure until the flame length is 300 mm (12 inches) when the burner is kept on the floor. Measurement of the flame height should be taken at the outermost tip of the flame.

8. Gently move the burner under the front lower edge of the tubing up to two third the length of the burner and the remaining one third exposed allowing the flame to lick in on the inside of the tubing.

9. As soon as the flame is applied to the tubing, start the stop watch, leave the gallery, and shut the entrance door.

10. Observe the test from the window and instruct the other operator to shut off the gas supply as soon as 60 seconds of ignition time is over.

11. Record the duration of continuous burning and the length of flame propagation after the burner flame is turned off.

12. Take pictures of the burnt section of the tubing before discarding the tested sample.

13. Turn off the gallery ventilation fan.

14. Repeat the entire procedure for the second sample of ventilation tubing in a still air environment.

15. Clean the test chamber and all the instruments when the tests are finished. Restore the instruments to their usual place.

16. Record any malfunctions of the equipment in the log book provided.

E. Evaluation Criteria:

1. Flame propagation beyond 1200 mm in the flowing air and 600 mm in the still air will constitute non-compliance.

2. The duration of continuous burning after removal of the ignition source shall not exceed 60 seconds in ventilated conditions, otherwise the product is not acceptable. There is no such requirement for the still air test due to a more stringent propagation criteria.

F. Safety Precautions:

1. At least two operators must be present during the course of the test.

2. Do not enter the gallery until the products of combustion are completely eliminated by ventilation.

3. Operators entering the test chamber should wear a gas mask during ignition of the sample and whenever there is a possibility of toxic gases present in the test area.

4. Ensure that all gas lines are properly secured and that there is no leakage before commencing the test.

5. Gas lines should be suspended from the ceiling or the side walls to prevent accidental tripping hazards.

6. The ignition torch must have at least 900 mm (36") long stem to allow a safe distance from the burner during ignition.

7. In case the fire gets out of control, shut off the ventilation; use a fire extinguisher or water spray from the existing water line located just outside the test chamber.

8. It is also desirable to wear fire-resistant gloves while operating inside the test gallery.

WARNING

The large scale gallery test was introduced at CEAL based on a very similar test (medium size) used by MSHA in the U.S. In our laboratory, there is a lack of ventilation control as the flow in the gallery appears to be non-laminar. Although nominal velocity is 1.5 m/sec, we have recorded velocities ranging between 0.6 and 2.3 m/sec. The large scale gallery test still requires some improvements, and therefore, it is being used as an interim test with a view to assessing its suitability relative to other tests.

A responsible engineer must be present to supervise and to advise the technicians where necessary.

CONCLUSION

This document will serve to train new operators as well as assist the present operators to conduct the required tests in a safe, systematic

and organised manner. It is recommended that improvements in the test equipment and procedures will be introduced from time to time.

ACKNOWLEDGEMENTS

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REFERENCES

1. CSA standard C22.2 No. 30.

2. Flamability training course material by N.K. Sarin.

3. Interim large scale test for rigid ventilation tubes by Dr. K. Mintz, July, 1985.

ENERGY MINES AND RESOURCES
Mining Research Laboratories

Fire-resistant Tests - Rigid Duct Materials

Manufacturer: ..... File: .....

Tested by: ..... Checked: .....

Product
Identification: .....

Continuous burning times in seconds.

Trial #	CEAL Gallery Test		Other Observations
	still air	ventilated	

Ventilation: Ambient Temp:

Remarks: .....

.....

.....

Verdict: Pass/Fail Reported by: .....

Dated: .....

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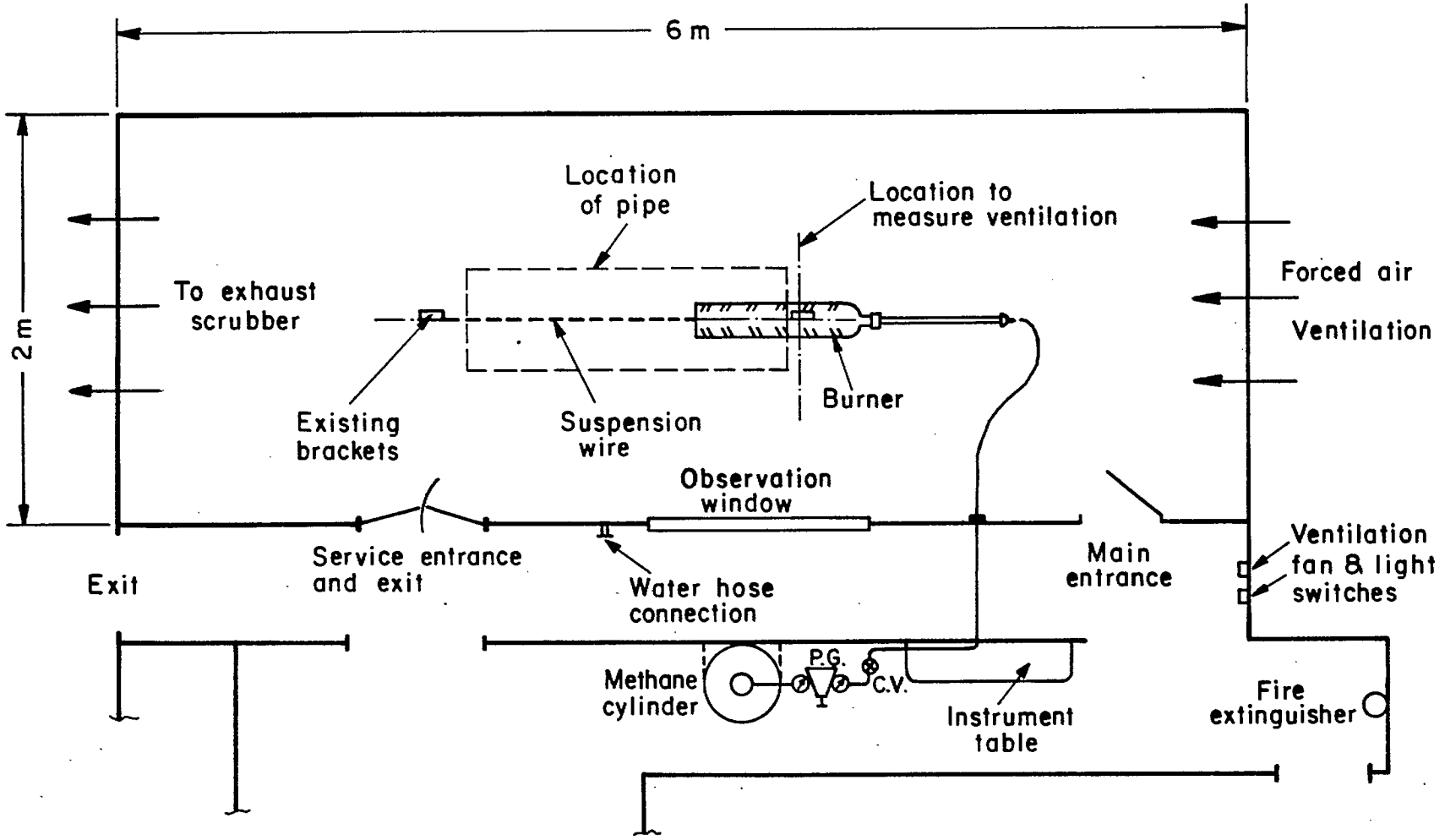

Fig. 1 - Layout of large scale gallery test for rigid plastic ducts.

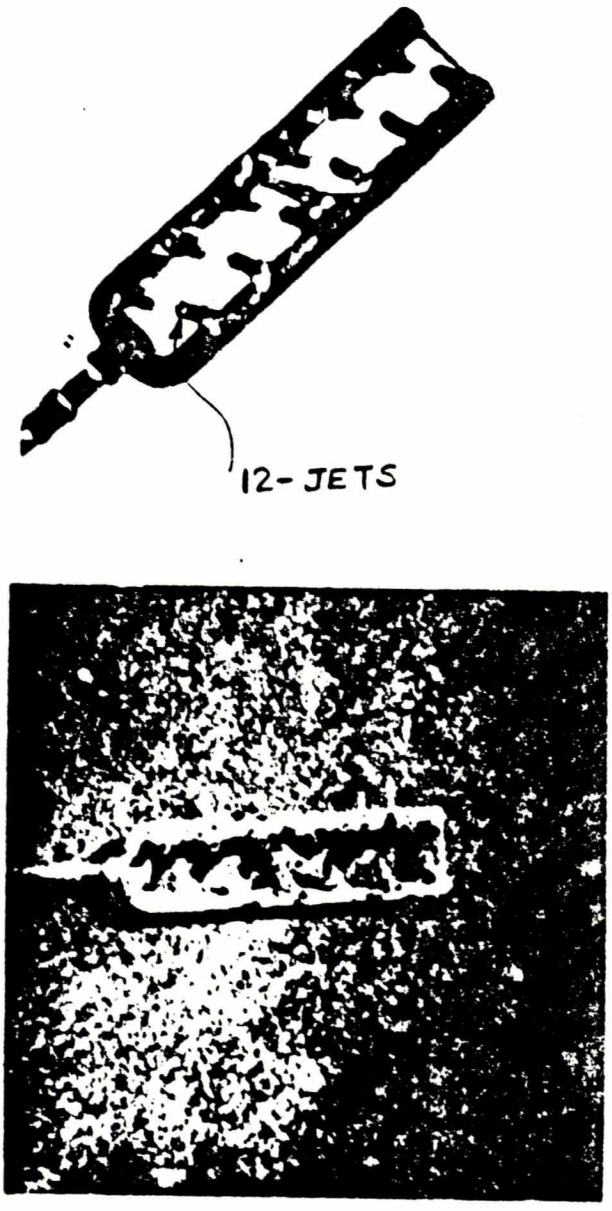

Fig. 2 - Jet burner for large scale test.