Application Notes

A special application of permanent vibration monitoring from a leading French iron and steel plant

Not every application of permanent vibration monitoring is intended to detect developing problems. This application note gives such an example.

The site of the application is a leading iron and steel plant. A hopper empties, alternately, sinter and coke into a blast furnace. The process is controlled by computer, and this needs to know each time the hopper empties completely. Brüel & Kjær provided the solution using an accelerometer and the Type 2505 Multipurpose Monitor, a system which has outperformed the originally installed permanent weighing system and X-ray device.

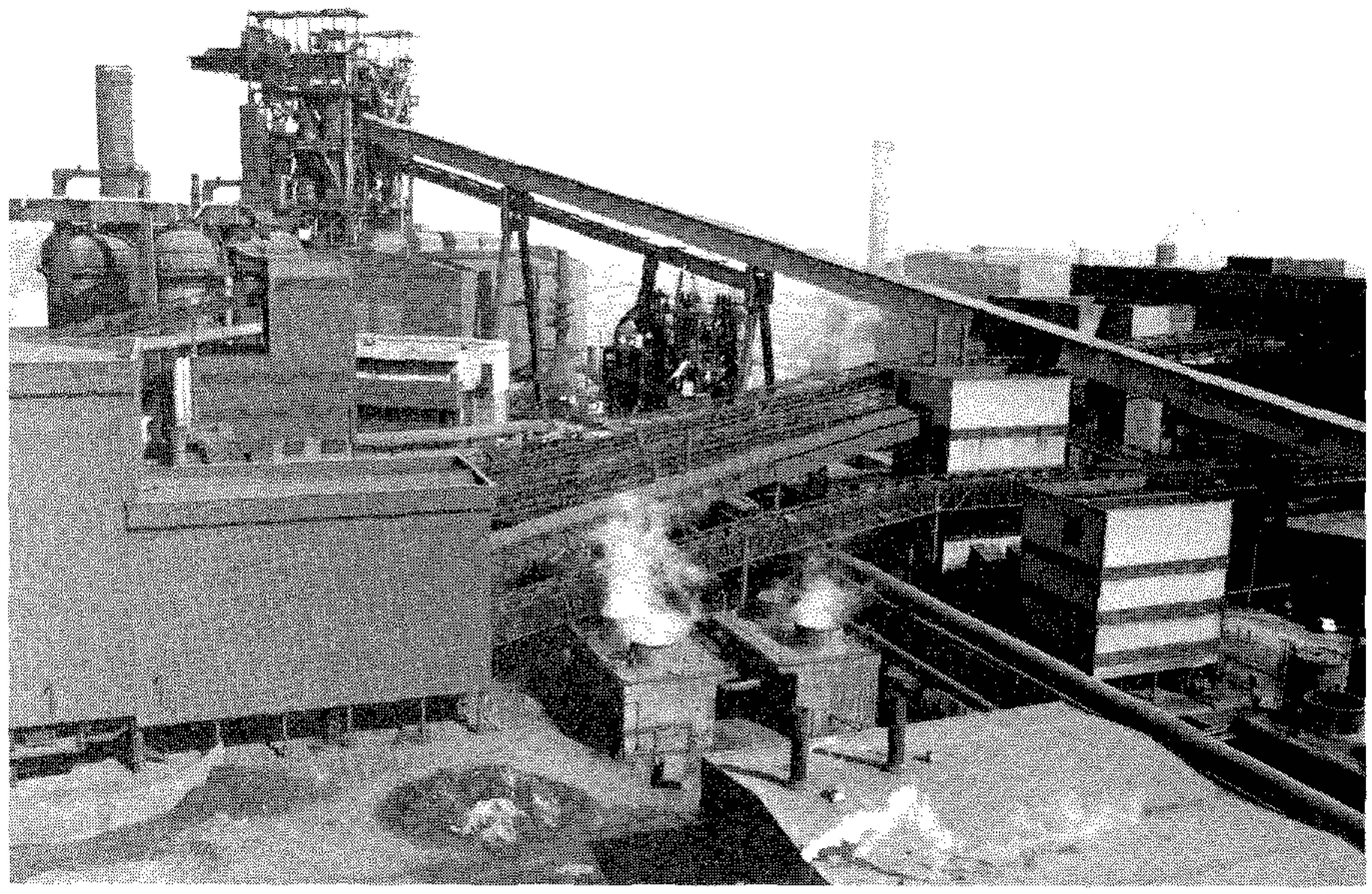

Photo courtesy of Sollac Dunkerque, France

A scene from the iron and steel plant, showing the conveyor carrying the iron-ore sinter and coke, up to the hopper feeding the blast furnace

Setting the scene

Sollac Dunkerque is one of the biggest plants in the steel group Sollac. The planned 1988 steel production is 5,2 million tons. Special products as well as mass products are produced, requiring strict quality control and continuous equipment updating.

24 hour, year-round operation

This facility was the first integrated plant in Europe to manufacture steel exclusively with the continuous casting technique. The blast furnaces are fed with the sinter and coke via cone shaped loading chambers, called hoppers. Each hopper is supplied by a conveyor belt, bringing the materials up to the top of the installation, as shown in Fig. 1.

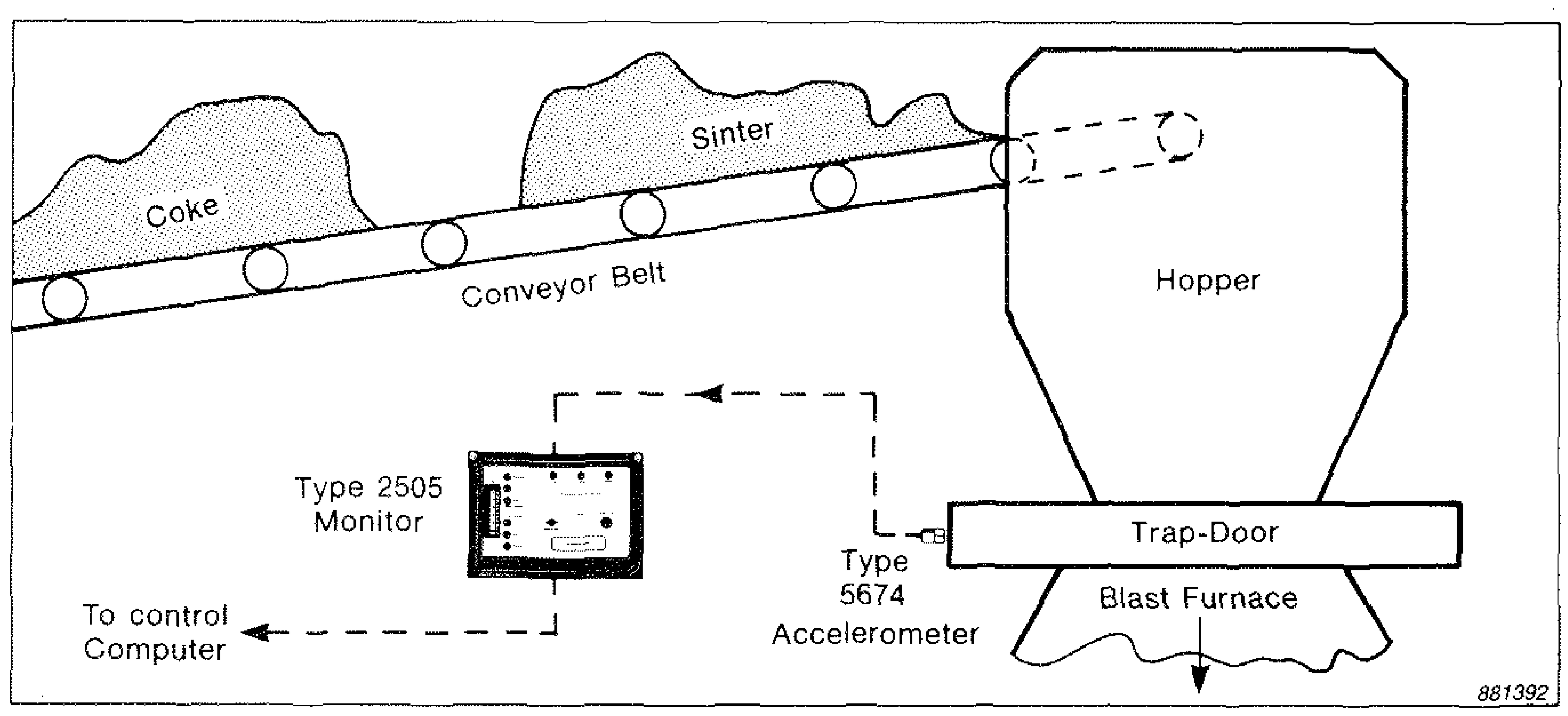

Fig. 1. Schematic diagram showing the hopper and trap-door, and the loading conveyor belt

The loading cycle, which continues 24 hours a day, is generally as follows: The trap-door at the bottom of the hopper is locked and sinter is poured in from the conveyor belt. Then the trap-door is unlocked and opened gradually, so that the sinter enters the blast furnace at an almost constant rate. When the hopper is emptied the trap-door is opened fully, then closed and locked. Coke is then poured into the hopper, which suffers exactly the same fate as the sinter, thus completing one loading cycle!

Room for improvement

The operation of each blast furnace is controlled by computer. This needs to know each time the hopper empties completely. This information was originally provided by a permanent weighing system and an X-ray device. The lack of accuracy of this method meant, however, that the computer delayed the final closing and locking of the trap-door, to ensure nothing remained in the hopper. Since this delay was around ten percent of the total emptying time, a certain loss of production capability was incurred.

An application for B & K

Sollac knew that the end of emptying could be judged more accurately by a man, standing up on the hopper, listening to the materials running. So when blast furnace number three was stopped for renovation, Sollac asked Brüel & Kjær to investigate installing a 'sound level meter' to detect the end of emptying of the hopper.

The Type 2505 Multipurpose Monitor is the solution

After the Brüel & Kjær engineer had studied the problem, vibration measurement using an accelerometer rather than acoustic measurement was selected, as consistent results could be obtained simply, without special techniques to reject influences from other noise sources. Measurements further indicated that similar vibration level patterns during hopper emptying, for coke and sinter, were obtained in the 16 kHz octave band. This allowed the use of a single channel vibration level sensor in this band. The solution settled upon employs a Type 5674* accelerometer and Type 2505 Multipurpose Monitor specified with the 16 kHz octave bandpass filter. The Type 2505 is designed primarily for permanent installation to monitor vibration levels of continuously operating machinery. There are three preset level detectors—When the vibration signal falls below a preset value, 'Minimum Level' is indicated. When it exceeds a preset value, 'Alarm Level' is indicated. When an even higher level is exceeded, 'Trip Level' is indicated. It also has facilities to initiate remote alarms via built-in relay circuits.

The vibration patterns obtained during sinter and coke emptying are shown in Fig. 2. The points labelled on this diagram, corresponding to specific events of the emptying cycle, were identified by synchronising with the command signal from the control computer to unlock the trapdoor, and visual observation. The Type 2505's 'Alarm Level' relay is read by the computer during the emptying part of the cycle only. With this preset level set around 40% full scale, as indicated in Fig. 2, the relay operates throughout emptying, until completion, and this is what the computer looks for.

Fig. 2. The Type 2505 Multipurpose Monitor

Making it a success story

Making any application a success story needs more than just a good idea. A professional approach to identifying the best solution and selection of hardware is equally important.

Equipment selection

The Type 2505 is designed for use in industrial environments, being built to USA 'MIL' specifications for shipboard equipment in a totally enclosed weather-proof box. The Type 5674* is a high sensitivity 'industrial' accelerometer, which with heavy duty low noise transducer cable AC 0077 crimped onto it, is recommended for use in severe environments, at temperatures of up to 250°C. An industrial accelerometer with a strong cable was obligatory for this application.

Reliable performance

The system described above has been in continuous operation since 1984, without any problems. Reliable performance is obviously important in a production process, where failure translates into lost production. Sollac confirmed their satisfaction with the system reliability, by ordering another in 1987, when blast furnace number four underwent renovation. This has now been operating since November 1987.

Economic sense

The accuracy achieved by the vibration monitoring system, detecting the end of emptying with a precision of plus or minus one second, has enabled production gains over that achievable with the original system installed on the blast furnaces. Sollac claim that, through these gains, the first system paid for its aquisition and installation costs within a period of one month. They are hoping to further capitalise on their investment, by making statistics about the duration of the process, in order to optimize the loading of the conveyor belt.

Acknowledgements

Thanks are due to Mr. Philippe Vervoort of Brüel & Kjær France, and to Sollac Dunkerque (in particular EMTN Vibration Dept. and men from HF 3 & HF 4), for supplying the material and the permission to use it for this application note.

* The Type 5674 has since been superseded by the Type 8315

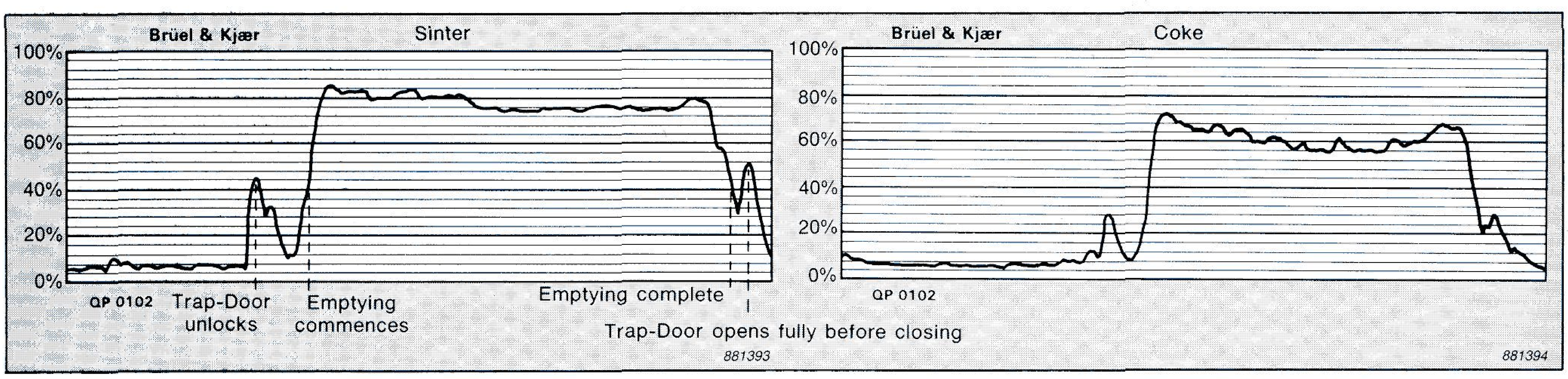

Fig. 3. Vibration level patterns obtained during emptying of sinter and coke, showing the incidence of critical events

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