U-Tech:
Underground Technology Cutting Edge Technical Information For Utility Construction & Rehabilitation

Sewer Defect Codes

Orgin And Destination

By Rod Thornhill and Phil Wildbore

Sewer defect coding has become of paramount importance for the worldwide sewer rehabilitation industry to ascertain critical information regarding the underground infrastructure. It is significant for all elements dealing with sewer systems – municipalities, consulting engineers and contractors – to understand the origins and ultimate goal for defining sewer defect codes. Early research and development in the United Kingdom paved the way for the development of NASSCO's Pipeline Assessment & Certification Program in the United States and related programs around the world.

It is not surprising that formal sewer defect coding began in the U.K. Although not totally driven by catastrophic collapses of the collection system, by the 1970s the number of large trucks disappearing through holes in the road caused by sewer failures was increasing.

The "Commissions of Sewers" was established in 1427 during the reign of Henry VI, and the U.K. developed a Bill of Sewers by 1531. In more modern times, the Land Drainage Act of 1930 gave rise to the concept of the "Catchment Board," responsible for discreet river basins. Modern times also created an awareness for better management of water quality related infrastructure.

Enactment of Public Law 92-500, the Clean Water Act of 1972, meant big changes in the way the federal government approached water quality in the United States as well. This landmark legislation included the establishment of the Environmental Protection Agency, the Construction Grants Program and the National Pollution Discharge Elimination System (NPDES).

Changes were also occurring in the U.K. Like the United States, 20th century water and wastewater service in the U.K. was primarily individual authorities or municipalities, regional authorities and some private water and wastewater providers. The Water Act of 1973 transformed the many disparate public water agencies into 10 separate Regional Water Authorities (RWAs) to supply water and wastewater services. The RWAs were divided along river basin boundaries and were named for the corresponding region they served. The primary reason regionalization was imposed was to create more efficient operations, raise the level of technology and expertise, and give the control of water quality in a particular drainage basin to a single authority. As a result, the staffing levels decreased between 1974 to 1989 from 80,000 to 50,000.

Privatization

The U.K.'s Water Act of 1989 enacted by the Thatcher government effectively privatized the 10 Water Authorities into Water Utilities, and by 1995 transferred the responsibility of quality regulation to the Environment Agency. In 1989, the Office of Water Services (OfWat) was established as the price and service regulator for the privatized water utilities in England and Wales.

An increasing awareness that better management of infrastructure was needed, along with the occurrence of several highly publicized pipe failures, prompted the creation of the Standing Committee on Sewers and Water Mains of the National Water Council. The Standing Committee's first report was titled "Sewer and Water Mains – A National Assessment (U.K., 1977)." Conclusions from the report were:

- Recognition that infrastructure needs in the U.K. was transitioning from expansion to renewal;
- A lack of basic asset condition knowledge was evident;
- Better condition assessment and cost tracking was needed; and
- Identified need for research to improve asset management and renewal.

This resulted in a project by the Water Research Centre (WRc) and the Transport and Road Research Laboratory to develop a methodology for describing internal sewer pipe conditions. The Transport and Road Research Laboratory Supplementary Report 377 (TRRL 377) was the beginning of sewer defect coding using the WRc method. The codes used in TRRL 377 are sometimes referred to as the "Embryonic Codes" since they preceded the first WRc Manual of Sewer Condition Classification (MSSC). These codes still form the backbone of all WRc related coding systems.

Beyond identifying conditions within the sewers, it was also recognized that more research and knowledge was needed to interpret the conditions and understand the mechanisms for pipe failure. Therefore, WRc began the development of what would become the Sewerage Rehabilitation Manual (SRM) in 1978.

Since May 1978, pipe defects from internal surveys of sewer systems have been analyzed to determinee the causes of premature pipeline failure. Correlations have also been identified with key environmental factors that accelerate these failures. An objective in the initial research over 25 years ago was to establish the types and frequency of observed defects within the sewer pipes, what these meant, and from these make confident provision for a future rehabilitation program at least cost. At that time, sewer survey methods were in their infancy, so "how good is the data we can get" and "how do we improve on this" were basic questions. Systems for the recording, retrieval and analysis of data were also evaluated.

It became evident that broad categories of defined defects were required, together with a classification method. This initial system needed to be capable of abstracting data from written and CCTV type surveys, and provide a consistent approach in order to deliver confidence. The initial focus was on manufactured pipes like concrete and clayware, and not defects in brickwork and masonry sewers, but it was recognized that any base system of Defect Codes needed to have future flexibility to be extended as experience was gained.

Parameters

Important parameters survive today from this embryonic work in 1978, such as the definition of measuring where the survey starts and the distance to the defect; the adoption of a clock reference to specify the defect on the circumference of the pipe; and all of the 21 descriptions that follow.

The 1978 embryo codes contained seven structural condition defects:

- *Cracked 'C'* – lines visible, pipe pieces all in place;
- *Fractured 'F'* – cracks visibly open, pipe pieces all in place;
- *Broken 'B'* – pieces of pipe displaced, some could be missing;
- *Deformed 'D'* – out of expected shape, probably also broken;
- *Collapsed 'X'* – loss of all structural integrity;
- *Joint Displaced 'JD'* – faulty alignment between consecutive pipes;
- *Open Joint* 'OJ' – longitudinal movement between adjacent pipes.

Plus, seven service condition codes:

- *Tree Root Penetration 'R'*;
- *Infiltration 'I'*;
- *Encrustation 'E'* – typically dissolved salts deposited on pipe walls;
- *Obstruction* 'OB' – solid material causing hydraulic reduction;
- *Debris* 'DB' – organic/silty material, typically sedimentation;
- *Water Level 'WL'* – a short discontinuity in the pipe gradient; and
- *Line* 'LE' – a divergence to left or right.

And, two construction condition codes:

- *Defective Connection* 'CN' – wrongly positioned/inserted lateral pipe; and
- *Defective Junction* 'JN' – damage to a purpose-made lateral connector.

These 16 codes were – and still are – the fundamental codes for defects, and were quickly able to be uniquely abbreviated to facilitate a "shorthand" system, e.g., C = cracked pipe, F = fractured; R = Tree Roots; DE = Debris; JN = Junction.

By necessity, there were also five miscellaneous codes identifying the *Start 'ST'*, *Finish 'FN'* and *Abandonment 'SA'* of a survey, together with *Manhole 'MH'* and *Invert 'I'* codes. Interestingly, ★ was included to identify a *continuous defect*.

The codes were then supplemented by two factors. A descriptor, used to identify a type or location as:

- Cracked
  Longitudinal/circumferential/multiple, or
- Deformed
  % of pipe diameter lost
  (to nearest 5%), or
- Roots
  Joint (if at a joint).

Next, a modifier, used to visually quantify, as:

- Cracked
  Longitudinal
  Clock Reference
- Roots
  Joint
  Fine/Mass/Tap
- Infiltration
  "Clock ref"
  Seeper/Dripper//Runner/Gusher
- Encrustation
  Joint
  Heavy/Medium/Light
- Connection
  "Clock ref"
  Cracked/fractured/broken/deformed/intrusion.

In 1978 – somewhat in advance of widespread computer applications: 'Pipe fractured around a joint from 2 o'clock to 4 o'clock and from 7 o'clock to 10 o'clock with running infiltration through fractures would be reported as: FCJ02040710 IJR.

This defect coding system was tried on two, 300 meter lengths of sewer: one precleaned, one not. Operators were required to codify the defects from CCTV tapes and written reports. The new system indicated interpretation accuracy of 82 percent and without any operative pre-training. It also indicated that higher reporting accuracies were attained when the sewer was precleaned.

A quantitative and qualitative defect coding system for sewers had been proven, together with a simple FORTRAN computer application for data storage and analysis. It also made the case that only if a common format were adopted could "operator interpretation" be minimized and recommendations based on reliable information be made with confidence.

Continued motivations

A few years later, a House of Lords Select Committee said of the U.K.: "There is enough evidence to believe that there is a significant risk of decay in the sewerage system getting beyond the (owners) control. Too little has been spent on maintaining the system in the past, and the industry, faced with signs of accelerating failure rates, does not yet appear to be doing enough to contain the rate of decay." Fortunately, the public water industry of the U.K. had invested heavily and requested WRc to implement a major program of research into all problems relating to sewer systems. The major output of this was the Sewerage Rehabilitation Manual (SRM) in 1983.

The SRM had five major impacts on the 1978 embryonic sewer defect codes:

- It recognized that 80 percent of the costs of dealing with sewer incidents were focused on around 10 percent of the sewer network;
- It recognized that not all sewer defects were equal. Some were highly important, others were less;
- It recognized that environmental factors referenced in the initial 1978 work were key factors in accelerating the decay of a defective sewer;
- It recognized that the 1978 defect classification work needed to be a national document to provide a common framework; and
- That the nature of the defects would be a critical factor in any successful rehabilitation program.

In referencing the first point, the concept of Critical Sewers was born. Sewerage/collection systems by their very nature tend to be substantial in asset value and pipeline length, yet because most of the flow is dependant upon gravity, they function well. Knowing that such a small portion of the network was responsible for such extensive costs, a set of rules for the U.K. industry were identified which located these critical sewers. These then became a more manageable proportion of the network – in 2003 these equalled 77,811.53 km of the 302,078.70 km total – and are the primary sewers to be managed on a pro-active basis.

The second issue was addressed by devising a scoring system for each defect. This was formulated from hundreds of visits to actual sewer collapses and distress testing of pipes in laboratories. These also established the collapse mechanisms prior to failure and identified the important indicators. The scoring system for the Internal Condition Grade (ICG) ranks sewers into five grades, with '1' being good and '5' being bad.

It is easy to see how consecutive surveys applying a scoring would indicate a deterioration profile.

Environmental factors

The application of environmental factors followed on from the scoring sytems and improved on the internal condition grades, taking into account external factors like construction techniques, hydraulic stresses, surrounding soil, etc. It is evident that a pipe laid with concrete bed and surround is inherently stronger than a plain pipe laid in bare earth, yet the CCTV camera cannot appreciate this. Likewise, a defective pipe subjected to regular internal hydraulic surcharge, or one laid in very poor ground – or both circumstances combined – is much more likely to deteriorate faster than a similar pipe not subject to such adverse conditions. Tabulations within the U.K. SRM enable such additional risks to be factored onto the internal condition grade to generate a structural performance grade.

Application since 1983 for the now privatized U.K. water and sewer utilities indicate the following asset balance, with a rehabilitation rate of 0.06 percent or 0.2 percent of the critical sewers/year.

As a result of the early work developing the SRM, the industry was delivered an expanded 'Manual of Sewer Condition Classification' (MSCC1) in May 1980.

MSCC1 Codes – May 1980 to 1988

The major development within MSCC1 was the specific coding regime for brick sewers, as the development of the Sewer Rehabilitation Manual to be released in 1983, had indicated a different set of collapse mechanism for brick sewers than with pipe sewers. The brick codes only amended the Structural

Condition elements, with Service Condition and Construction Features relating equally to both brick and pipe sewers.

The MSSC1 Structural Condition codes for pipe sewers were identical to the embryo codes, and retained the same modifiers. Service Condition codes added '*Scale (ES)*' as a separate code to *Encrustation (E)* to represent solid deposits such as corrosion within iron pipes, or hardened grout. Construction Features expanded considerably from the *Defective Junction/Defective Connection* in the embryo codes. In total three new codes were added for:

- *Junction 'JN'* - a purpose made or preformed connection built into the sewer line during construction;
- *Connection 'CN'* - a lateral pipe added to the sewer post-construction;
- *Major Branch 'BR'* - applied to sewers >900mm diameter, to represent drop shafts, air vents, overflows and comparably sized pipes to the main sewer;
- *Intruding 'I'* was also incorporated as a descriptor, primarily for use with *Connection* to reference a lateral pipe which intrudes into the main sewer.

The Miscellaneous codes were also widened with three new codes to signify:

- *Diameter Checked 'DC';*
- *General Condition Photograph 'GP'*, and
- Camera Underwater 'CU'.

The new codes for brick sewers accessed the same range of modifiers as the embryo codes but specified nine distinct codes:

- *Mortar missing 'M'* - between bricks, with bricks still in place. Split into three modifiers of *Surface*(<15mm)*; Medium(15-50mm); and Total(>50mm);*
- *Cracked 'C'* - as per pipe codes, and with bricks still in place*;*
- *Fractured 'F'* - where bricks have moved apart;
- *Displaced Bricks 'DB'* - where single/ areas of bricks have moved from original position;
- *Missing Bricks 'MB'*- where single/areas of bricks are missing;
- *Surface Damage 'S'*- by *spalling* where pieces have splintered off, or *Wear,* e.g., such as by the action of cleansing tools;
- *Deformed Sewer 'D'* - where original cross section of sewer is altered;
- *Dropped Invert 'DI'*- where there is a pronounced gap between invert and sewer wall.

MSCC1 comprised:

- Seven Structural Condition codes for pipe sewers – C,F,B,D,X,JD,OJ;
  - With six modifiers – L,C,M – for describing the alignment of the crack/facture, and S,M,L – to quantify the other defects. (These were related to the pipe wall thickness 't', where Small <t; Medium t-1.5t, and Large >1.5t;
- Nine Structural Condition codes for brick sewers – M,C,F,DB,MB,S,D,X,DI
  - With ten modifiers – L,C,M as per pipe sewers; S,M,T for the missing mortar; S&W for the spalling/wear of *Surface Damage*; and, V&H for the horizontal/ vertical indication of *Deformation*.
- Eight Service Condition codes – R,I,E,ES,DE,OB,WL,L;
  - With sixteen modifiers:
    - Fine 'F', Mass 'M', Tap 'T' for *Tree Roots*,
    - Seeper 'S', Dripper 'D', Runner 'R', Gusher 'G' for *Infiltration,*
    - Heavy 'H' (>20%), Medium 'M' (5-20%), Light 'L' (<5%) for *Encrustation* and *Scale*;
    - Silt 'S', and Grease 'G' to describe *Debris,* and
    - Left 'L' Right 'R' Up 'U' Down 'D' to reference *Line.*
- Six Construction Features codes – JN,JX,CN,CX,BR,MH
  - With a descriptor Intruding 'I'.
- Six Miscellaneous codes – ST, FH, SA, DC, GP, CU.

The MSCC1 also included formal rules for coding continuous defects instead of relying on the asterisk notation. Also improved rules for data entry set the stage for better computerization of coding.

MSCC2 published

The codes in the MSCC1 served the U.K. water industry for eight years, through a process of regionalizing the industry into 10 water and sewer authorities. In 1988, MSCC2 was published in time for the privatization of the 10 regional water and sewer companies in 1989, and formed part of a suite of publications covering sewerage data collection. This suite also incorporated Model Contact documents for the sub-letting of survey work to private contractors, for both man-entry and non-man entry sewer surveys. Over 60 percent of MSCC2 was dedicated to the "Standardized Coding Form." This enabled all CCTV and man-entry surveys to record data in the same format, and provided for 33 fields in the header details to accurately specify each sewer length. (Another of the "suite of publications" dealt with a process of giving every manhole in England and Wales a unique, 10-digit reference number for the upstream and downstream manholes. This avoided the random allocation of start and finish manholes, and the subsequent poor assignment/recollection of videotapes to surveyed sewer lengths.)

A Standardized Coding Form was split into two sections: the header and the body of the recording format. The 33 fields in the header recorded details such as: who did the survey; at what time/date and what was the weather (important for I/I surveys); what is the use/depth/shape/material/year laid of the sewer and where is it positioned (road, field, etc.)? Clock referencing of defects was retained without modification from MSCC1/embryonic codes.

MSCC2 Codes – 1988 to 1993

Structural Condition Codes for Pipe Sewers incorporated *Surface Damage* – previously only applicable to brick sewers – with the same two modifiers of spalling and wear. This now made eight structural condition codes for pipe sewers.

Structural Condition Codes for Brick Sewers were unchanged, as were Service Condition and Construction Feature Codes. Miscellaneous Codes gained three new codes to record changes to *Lining 'LC'; Material 'MC'; Shape 'SC'; and Pipe Length 'PC'*. A code to record *Vermin 'V'* was also added to bring the total number of Miscellaneous Codes to eleven.

Significant emphasis was made of the Continuous Defect Facility, - previously only half a page in MSCC1 – and covered truly continuous defects, repeated continuous defects, and wandering defects.

A truly continuous defect extends beyond one meter and without interruption. A typical example is longitudinal fracture/cracks, or missing mortar.

Repeated continuous defects occur at regular intervals, and can be exampled by circumferential fractures, encrustation and open gaps at pipe joints. Use of 'repeated' means that at least three out of every four joints are affected.

A wandering defect is the same defect that has a change in "clock' reference."

At this point, the MSCC2 codes were adopted by water utilities in Australia. While some changes were made to accommodate differences in conditions and materials, the MSCC2 codes and methodology was largely adopted into the first Australian Conduit Evaluation Manual (ACCEM, 1991, Australia).

MSCC3 – August 1993 to January 2004

The wider availability and application of computer coding programs for recoding and analyzing CCTV data in particular, required an expansion of all codes to assist with this implementation. The opportunity was also taken to simplify the coding process and provide a more comprehensive set of comparative photographs.

The adoption of Critical Sewers as a primary means of regulatory monitoring in the U.K. led to the inclusion of a data field to signify the sewer category. Pre-Cleaning of the sewer, where positively known, was also included for contractors to record.

Sewer Condition Codes was now grouped, and the separate code distinction between pipe and brick sewers removed. Fifteen years of implementation had identified the most common code/modifier combinations, so these were harmonized, and indices presented codes alphabetically, and in their groups: *Crack Longitudinal 'CL'; Crack Circumferential 'CC'; Cracks Multiple 'CM';* etc. While the demarcations remained between structural condition, service, construction and miscellaneous codes the 67 'Codes' were used and referred to as a single entity. The one significant entry was *Hole 'H'* to record a total area of missing pipe material. *Lining Defect 'LD'* was also added.

ICG	1	2	3	4	5
Score	<10	10-39	40-79	80-164	>165

International development

Australia - During the time of MSCC2, the major water authorities of Australia developed the first edition of the *Australian Conduit Condition Evaluation Manual* in June 1991. This 144-page book brought together MSCC2 with relevant text from SRM2, and the Model Contract Documents for man-entry and non-man-entry sewer inspections. Subsequently, the new Sewer Inspection Reporting Code for Australia was developed from the June 1991 manual and from EN-13508-2, primarily to benefit from the major technological advances. The updated Australian Code is scheduled to be published in 2005. The Australians remained faithful to the Euro Codes, where practical. However, the conditions encountered in Australia necessitated additional codes, particularly the unlined and plastilined concrete sewers. An effort is now underway to convert existing CCTV software versions to using the new codes, and to expand training on use of the new codes.

Canada – The North American Association of Pipeline Inspectors (NAPPI) adopted the WRc MSCC3 codes in the 1990s and provides training and certification on use WRc codes throughout Canada. Many public wastewater agencies, contractors and engineering firms thus have standardized on the MSCC3 codes.

ICG	1	2	3	4	5
UK 2003 Sewerage	60%	17%	13%	8%	2%

United States – NASSCO, the leading national trade organization for the rehabilitation industry, recognized the establishment of a standard for sewer pipeline assessment was greatly needed in the United States. NASSCO entered into an agreement with WRc for assistance in the development of a national standard for defect coding. The basis for the new standard was the MSCC3/EN13508: Part 2. The U.S. standard was called the Pipeline Assessment and Certification Program or PACP.

PACP development is comprised of the following components;

- PACP manual - Creation of codes, coding rules, code tables, photographs and descriptions of defects;
- Training course - Development of training modules and a network of trainers that provide training in a classroom environment. Attendees are tested on their understanding of the PACP material and receive PACP User certification upon successful completion of the class;
- PACP Standard Database – NASSCO developed a Microsoft Access database that serves as a means of exchanging PACP data between different software applications;
- PACP Software Vendor Certification – NASSCO independently certifies that each CCTV vendor's software correctly implements the PACP codes and coding rules, and exports the PACP data to the PACP Standard Database format; and
- Grading – NASSCO developed a simplified method of assigning severity to the various defects and grading each pipeline similar to the internal condition grade used by WRc. The NASSCO grading does not include consideration of environmental factors such as soil type, groundwater conditions, surcharging or criticality of the pipe.

Although development of a U.S. standard for defect coding was long in coming, the fact that no standard yet existed provided some advantages for NASSCO. They were able to implement the PACP Standard Database without consideration of any previous CCTV legacy data issue already in use. The ability to start with a clean slate also precluded any other issues regarding transition from previous versions of coding such as operator certification, updates of the manual, or compatibility of software vendors.

Like the Australian Code, PACP has some differences from the Euro Code due to the nature of sewers and terminology in the U.S. However, since PACP has its roots in WRc/Euro Codes and WRc was largely responsible for the development of the PACP codes, integration with other WRc coding systems is manageable.

European Union - In producing the new 'Euro Code' – EN13508: Part 2 – in 2003, the knowledge and application from within the U.K. was substantially used to provide a common language throughout Europe for the exchange of information on sewer defects. The incorporation of condition codes for manholes and chambers led to the production of the latest Manual of Sewer Classification Version 4 (MSCC4) in January 2004. A simplified set of codes was also offered where internal drain sizes are less than 150mm (6 inches) diameter. In essence, the well established Manual of Sewer Condition Classification codes adopted and applied in the U.K. were deemed to be the most tried and trusted methodologies available. They also had the benefit of plugging these codes straight into the Sewerage Rehabilitation Manual and delivering a comprehensive asset management strategy for system owners.

The United Kingdom - Although still presented as a single manual, MSCC4 was separated into two parts, and included a set of eight ready reference laminated code sheets for use on site. Part A of MSCC4 includes drains and sewers, while Part B references manholes and inspection chambers. A similar format of Standard Coding Form is used for both parts, but is not interchangeable. MSCC4 was published in January 2004 and will become the U.K. standard in May 2005.

Asia and the Pacific Rim - Many countries are now undertaking the development of standardized CCTV coding, including Malaysia, Singapore, Indonesia, Thailand, Philippines, Brunei, Cambodia, Vietnam, Laos and Burma with assistance from WRc and in accordance with the EN13508 Part 2 framework.

What lies ahead?

What might be the future application of "The Codes"? The original work in 1978 identified that assessing the internal condition of a pipeline is only part of the story. Not only do these defects need to be ranked in some order of severity, but also together with external factors such as the soil type surrounding the pipe and frequency of surcharging within the pipe: for example, can a true likelihood of failure be implied? The Sewerage Rehabilitation Manual Version 4 remains the source for this type of data as proven for U.K. conditions. Elsewhere, tools such as the SRM need to be developed.

Doubtless, technology will advance to include lasers for accurate internal measurements, thereby replacing some of the more subjective assessments. Engineers can already have circular images along the axis of the pipe laid out as a flat piece of paper. Emerging technology enables U.S. to prepare for surveys other than visual such as applying microwaves to see through certain pipes to find voids, tree roots and obstructions to some rehabilitation options; or the use of infrared, sonar or holographic methods. Most will start a specialist application, but even at this stage data will need to be recorded in an efficient way. Mass-market applications will make this doubly important. Some utilities already envision having the equivalent of medical "body scanners" for use from the street surface to evaluate all assets – and within the next decade.

Camera technology, with GPS to provide location, and "wireless/remote" operation, will remove the current restrictions of tethered cameras. This will enable much more of a network to be surveyed and the automatic coding/recording of defects.

Programs are also well advanced that can take coded CCTV surveys as a component to the computerized rehabilitation of sewer systems to define whole life costs and maximize asset life.

In the meantime, however, the one-on-one interaction of man and machine will remain the predominate tool for assessing the inside of a sewer pipe. Only adhering to a standard descriptive and visual reference will the data derived contain the constancy and confidence necessary to base the magnitude of decision needed for sewer renovation.

Summary

Development of a standardized approach to internal sewer pipeline assessment is recognized as an indispensable first step in improving sewer asset management. While each of the current WRc lineage coding standards has provincial difference, they all have the commonality of the EN-13508 Part 2 standards. The establishment of these coding standards in the United States, the U.K., Australia, Europe and other countries around the world will enhance the technology of sewer asset management everywhere.

About The Authors:

***Rod Thornhill** is president of White Rock Consultants with offices in Dallas and Fort Worth, TX. He was instrumental in adapting the WRc codes to a U.S. standard and helping to launch NASSCO's PACP.*

***Phil Wildbore** was the primary contact with WRc during implementation of the PACP, and managed similar projects for WRc throughout the world. He recently joined the Department for Environment Food and Rural Affairs and will head a new effort to improve the management of private sewers and drains in the U.K.*

Sample of Defect Codes

Defect Description	EN13508-2 Code	WRC Code	PACP Code
Surface Damage Wear	BAF (A or B)	SSS, M, L	SRI, SAV, SAP SRC, etc.
Displaced Bricks	BAD A	DB	DB