



## PROBLEMS WITH USING THE AGS FORMAT AS A WORKING DATABASE STRUCTURE

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**SYNOPSIS:** The AGS format was designed as a data transfer vehicle. Over the years since its release the format has proven its effectiveness in this regard. Too often, however, the format has been adopted as a working database structure. For this purpose the format is deficient in many areas and such structures can lead to awkward data entry procedures, difficulty in data validation, reduced querying capabilities, and loss of information. This paper points out some of the weaknesses in the structure as a working database and illustrates methods to structure databases so as to achieve the maximum benefit to the user while still maintaining the ability to read and write AGS format files.

### 1. INTRODUCTION

Containerisation revolutionised freight shipping in the 20th century. Freight generators, freight transporters, and freight consumers now had a common interchange medium. As long as all involved in the process followed simple, well defined rules concerning the container dimensions, freight moved simply, quickly, and easily with little time, effort, and money lost at interchange points.

The AGS interchange standard has performed a similar service for the Geotechnical and Geoenvironmental industries. However, unlike the users of containerised shipping, many users of the AGS standard have adopted the interchange standard for their usage standard. Imagine a furniture maker storing the components of each piece of furniture in standard shipping containers in the factory or a furniture retail store leaving the furniture in the standard shipping containers on the display floor. In reality the furniture factory stores the furniture components in a manner that makes sense to its production process and the furniture store displays the furniture to best show the furniture for sale.

Granted that much of the AGS standard can be adopted as a usage standard, there are many areas of the standard that act quite well for the purpose of data interchange but are less than optimal for the purpose of data collection, validation, and manipulation. The basic thesis of this paper is that usage databases need to be set up to best meet the requirements of the users of the data. The interchange medium should only affect the design of the usage database minimally. Even table and field names in the working database do not need to match the AGS groups and fields. Care must only be taken to ensure that the usage database can be mapped to and from the transfer standard.

This paper illustrates a number of examples of how the usage standard can be designed to better meet the user needs but still meet the requirements of the interchange standard. The examples are few in number but illustrate some basic classes of problems and optimisations. We hope that they will serve to stimulate the industry to think first in terms of usage requirements and then of interchange requirements.

### 2. COMPONENT DESCRIPTIONS

Following are some typical samples of soil descriptions:

Top (m)	Base (m)	Description
0	0.9	Loose dark brown sandy fine to medium SAND with some roolets (TOPSOIL)
0.9	3.5	Stiff brown with blue veining silty to sandy CLAY with some fine to medium sub-rounded gravel of mixed lithology
3.5	5.5	Stiff brown silty CLAY with some fine to medium sub-rounded gravel and coal fragments, locally a firm, grey silty clay and brown silty fine sand at 4.50-5.00m (GLACIAL DEPOSITS)

Figure 1. Typical Soil Descriptions.

This will be designated as the "blob model" of descriptions, a coarse-grained approach. Following are the same descriptions in a "component model," which comprises a fine-grained approach:

Depth (m)	Base (m)	Strength	Colour	Minor Constituent 1st	Minor Constituents Conjunction	Minor Constituent 2nd	Particle Size 1	Particle Size Conjunction	Particle Size 2	Principle Type	Additional Description	Formation
0	0.9	loose	dark brown	sandy			fine	to	medium	sand	with some roolets	topsoil
0.9	3.5	stiff	brown with blue veining	silty	to	sandy				clay	with some fine to medium sub-rounded gravel of mixed	
3.5	5.5	stiff	brown	silty						clay	with some fine to medium sub-rounded gravel and coal	glacial deposits

Figure 2. A component model of soil descriptions.

There are many strong advantages to using the component model for data entry:

1. Consistency - Consistently structured descriptions are always produced.
2. Enforced Attribute Selection - Most of the components would have valid data lists associated with them, from which the user chooses. Such data lists aid in data accuracy and consistency. All of the above components, except for "Colour" and "Additional Description," are such lookup lists.
3. No Formatting - Formatting is removed from the data. The burden of the formatting is taken from the user and imposed on the software. Further, the formatting can then be altered as needed without changing the data. Note in Figure 2 above that all the components are lower-cased but the final descriptions (Figure 1) are mixed-case. Punctuation is also inserted by user-defined rules. In the above example, all components are separated by spaces (except for the formation which is placed on its own line). However, variable punctuation is possible with commas, full stops, colons, etc. placed after any component. Note also the brackets around the formation name. Other component formatting, such as bold, italic, underline, colour, etc., are also possible. Finally, the order of the components can be changed at will. User-definable software rules determine the final look of the description.
4. Selective Reporting - Not all components may be desirable under some situations. On a log form the full description is usually shown. On a section showing a number of borehole sticks there is less room, so perhaps only the "Principal Type" and the "Strength" would be shown.
5. Enhanced Query Capabilities - Queries can be run on any combination of components. For example, one could ask for N Value results within layers whose "Principal Type" is "sand."
6. Validation - Data validation becomes possible. A simple rule could catch "hard sand" or "loose clay."

The level of granularity depends on how the data will be used (what information is important to the final usage of the data) and on how much the organisation prizes consistency. Component models can have any number of attributes. They can be as small as three components (principal material, strength, and additional description). The sample above shows only 11 of the 20 actually in the model. Furthermore there is another table for rock descriptions that contains another 12 components.

As an example of how fine this process can go, seven component colour models are sometimes used:

Intensity 1	Qualifier 1	Colour 1	Colour Conjunction	Intensity 2	Qualifier 2	Colour 2
light	greenish	red	to	dark	bluish	yellow
medium	pinkish	brown	and	light	greyish	green
very light	reddish	yellow	mottled with	very dark	yellowish	blue

Figure 3. A fine-grained colour model.

Each of these components would have a valid value list of allowable choices associated with them.

Some components can be "overloaded." For example, the "Strength" component of Figure 2 has both consistency values for fine-grained soils and relative density values for coarse-grained. This makes the rule for checking if a value is appropriate a bit more difficult to write but, having the rule written certainly makes for easier data entry. Alternatively, one could have two fields: "Consistency" and "Relative Density." This makes the rule writing easier since values cannot exist in both and consistency only applies to silts and clays while relative density only applies to sands and gravels. However, it does make data entry a bit inconvenient in that the user must select the appropriate field for each record.

### 3. TCR, SCR, RQD

The TCR, SCR, and RQD values are stored in the AGS format as percentages. For interchange purposes this is appropriate. However, these are not the values collected in the field. Lengths of core are collected to determine these values. In the data generator's database it is more appropriate to store the recorded lengths, not the calculated percentages. There is always the possibility of entering data incorrectly into a database. Storing calculated data doubles the chance of an error, performing the calculation and data entry. The formatting of data should be the responsibility of the reporting engine and the export facility that maps to the AGS structure.

### 4. LAB CALCULATIONS

For a data generator performing lab testing, the AGS structure is woefully inadequate. Many more fields are necessary to store the raw data. What is commonly done is for the lab calculations to be performed in a separator program, generally Excel<sup>®</sup>, and the data imported into the storage database which mimics the AGS structure. Sometimes the data are taken directly from Excel<sup>®</sup> to an AGS file. This imposes an additional potential problem in that it is much more likely that the key relationships can be incorrect if the data are not first placed in a relational database.

Ideally, all the lab data will reside in the same file as the rest of the project data. Stored in a relational database, orphan records cannot be created and validation against other data can be made, for example, test depths within the parent sample extents.

Putting all lab data into the project database obviously requires a very different database structure than provided by the AGS. First, the CLSS table would need to be broken up to allow moisture content, densities, etc. to be calculated and documented properly. Many other fields and tables would also need to be inserted for both collected data and metadata describing the testing in more detail than is available in the AGS.

Another benefit of this configuration would be the ability to better track testing progress and final testing quantities.

Another important consideration is that the AGS structure has SAMP as the parent group for all lab groups. This allows specimens (SPEC\_DPTH and SPEC\_REF) to be defined without reference to any other specimen. Without a referential check related tests could then be input that appear to not be related but were in fact run on the same specimen. To fix this problem, an intermediate group is necessary that is the child of SAMP but the parent of all lab groups. A convenient existing group is the CLSS table. This forces all specimen keys to be defined so the data entry person can only select from the defined specimens when entering test data. Further, if a specimen reference or depth was input incorrectly, the incorrect value can be corrected in the parent table and this will cascade down to the child tables.

### 5. PARTICLE SIZE REDUNDANCY

The percent passing the 0.425mm sieve is stored in the CLSS group, the percent retained on the 37.5mm and 20mm sieves in CMPG, 20mm in CBRG and MCVG, and 37.5mm, 6.3mm, and 2mm in the RELD group. All of these data can be derived from the GRAD group data. In a working database, especially for a data generator, there is no need for this redundancy. The relevant percentages can be extracted from the associated GRAD data and the values exported appropriated to the AGS file.

## 6. PARTICLE DENSITY

The AGS standard requires that particle density needs to be prepended with a “#” if the value is assumed. This overloads one field with two pieces of information. Much better, from both the data generator and consumers standpoints, is to create two fields: one to hold the particle density and a Boolean (True/False) field to be marked if the value is assumed. This has the following advantages:

1. The particle density field can be made into a numeric field, thereby avoiding some typographical errors where a non-numeric might be typed. If a “#” were allowed, the database field would have to be a text field that allows any characters.
2. You can more easily use the particle density field in calculations on your reports, for example, to determine void ratio or degree of saturation. With a “#” prefix, your calculation expressions would first have to check for the “#” character and then strip it off before using it in the calculation.
3. Data entry is easier. The operator does not have to be told how to specify an assumed value. The additional field makes it clear.

## 7. CPT DATA

### 7.1. Background

Cone Penetrometer Testing (CPT) is high quality and cost effective in-situ soil test which is perhaps under supported by AGS Format. We consider the AGS format insufficient for some interchanger’s of CPT data, and after analysing three user group’s requirement, propose a working structure that could also be adopted as an interchange standard.

### 7.2. Practice

The reality of CPT data collection is that single and multiple pushes may take place in the one Hole ID. Each of push may be done using different equipment, on different days, drilling may take place between pushes, and a single data files is general created for each push. Metadata for each push is required for derivations, such as  $q_t$ , and quality control reasons, such as cone metreage. Multiple dissipation tests at differing depths may also be carried out within the one push.

Let us consider three geotechnical user groups of CPT data.

### 7.3. Offshore CPT

It is common practice to use CPT over short distances with in a deep borehole alternated with sampling and other in-situ testing as in the Figure 4 example. In this case each push is given a test number. Piezocones are commonly used, and metadata such as the cone-sleeve offset, initial hydrostatic pressure, net area ratio, and bulk unit weight are required to derive common parameters such as  $R_f$ ,  $q_{net}$  and  $q_t$ . Dissipation tests are common.

The screenshot shows a software application window titled 'INPUT - e:\data\paper\offshore eg.gpj: PCPT\_DETAILS table'. The interface includes a menu bar, a toolbar, and a navigation pane with tabs for 'Project', 'Borehole', 'Sample', 'Lithology', 'Remarks', 'PCPT', 'Dissipation Test', 'Method', and 'Shear Tests'. The main area displays two tables.

**Table 1: CPT Test Summary**

CPT Test Number	Data File Ref	Cone ID	uoi (MPa)	Alpha	Gamma Bulk (kN/m3)
C1	8202.001	040625	0.01909	0.75	18
C2	8202.002	040625	0.05929	0.75	18
C3	8202.003	040625	0.08442	0.75	18
C4	8202.004	040625	0.11457	0.75	18
C5	8202.005	040625	0.13165	0.75	18

**Table 2: Detailed CPT Data for C1**

Depth (m)	qc (MPa)	fs (MPa)	u (MPa)	incl	Total Stress (MPa)	qt (MPa)	qnet (MPa)	Rf (%)	Bq (%)
0.92	0.01	0	0.007		0.01656	0.030845	0.014285	0	117.9783
0.94	0.01	0	0		0.01692	0.029095	0.012175	0	79.27956
0.96	0.01	-0.0003	0.007		0.01728	0.030845	0.013565	-3	121.2781
0.98	0.04	0.0002	0.008		0.01764	0.061095	0.043455	0.5	39.69732
1	0.05	0.0003	0.022		0.018	0.074595	0.056595	0.6	54.86272
1.02	0.02	0.0007	0.011		0.01836	0.041845	0.023485	3.5	84.51629
1.04	0.03	0.0014	0.009		0.01872	0.051345	0.032625	4.666667	54.0927
1.06	0.04	0.0015	0.021		0.01908	0.064345	0.045265	3.75	65.05431
1.08	0.04	0.0012	0.038		0.01944	0.068595	0.049155	3	94.08183

Figure 4. Sample structure for offshore CPT data.

### 7.4. Reclamation CPT

Friction cones are generally employed and pushed once to refusal though sand and gravel to estimate density and identify silt layers. The soil type and regular refusal on hard ground leads to higher than normal wear of the cones. Metadata such as Cone ID and before/after test calibrations can be useful to track cone life as in the Figure 5 example.

The screenshot shows a software window titled "INPUT - e:\data\paper\rec example.gpj: STCG table Library: e:\data\paper\lib\_dev.glb". The interface includes a menu bar (File, Edit, Format, Tables, gINT Rules, Navigation, Add-Ins, Help) and a toolbar. Below the toolbar are tabs for "INPUT", "OUTPUT", "REPORTS", "SYMBOLS", "DRAWINGS", "DATA DESIGN", and "UTILITIES". A secondary set of tabs includes "Main Group", "Site Map", "Surfaces", "Depth Doc", "CPT", "Field Testing", "Monitoring", "Lab-Class", "Lab-Comp Rel", "Lab-Shear-Consol-Perm", "Lab-Chem", "Lab-Rock", and "Lab-".

Under the "CPT" tab, there are sub-tabs for "1 Static Cone", "2 Dissipation Test", and "3 CPT Report Scales". The main area displays a table for the "CPT group":

CPT Test Number	Type	Manufacture's Cone Type	Cone ID	Initial Hydrostatic u (kPa)	Net Area Ratio	Bulk Unit Weight (kN/m3)	Cone Diameter (mm)	Zero Before Tip	Zero Before Local Friction	Zero Before Inclination	Zero After Tip	Zero After Local Friction	Zero After Inclination	File Reference
1	EC	CF-10	050808					0.261	0.077	-39.582	0.286	0.077	-39.39	QCB500-1.213

Below this table, a text field shows "Name=STCN\_MNTY." and a "Row 1 Of 1" indicator. A second table, titled "Static Cone CPT1, 1", provides detailed data:

Depth (m)	Cone Resistance (MN/m2)	Side Friction Local (kN/m2)	Porewater Pressure 2 (kN/m2)	Slope Indicator 1 (deg)	Speed (m/s)	Total Stress (kPa)	qt (MPa)	qnet (MPa)	Rf (%)	Bq	GintUpdated
0.02	0.134	0.0		0.1593	0.0				0.000		12/10/2005
0.04	0.318	0.2		0.13	2.2				0.063		12/10/2005
0.06	0.534	0.8		0.1258	2.2				0.150		12/10/2005
0.08	1.107	0.7		0.1342	2.2				0.063		12/10/2005
0.1	2.112	3.7		0.1426	2.2				0.175		12/10/2005
0.12	2.920	3.3		0.151	2.2				0.113		12/10/2005
0.14	3.461	4.6		0.1677	2.2				0.133		12/10/2005
0.16	3.868	5.9		0.1174	2.2				0.153		12/10/2005
0.18	4.255	8.4		0.1384	2.2				0.197		12/10/2005

A "Row 1 Of 237" indicator is visible at the bottom right of the second table.

Figure 5. Sample data structure to store CPT data from reclamation testing.

### 7.5. Onshore CPT

With onshore CPTs, generally one push is done to a set depth or refusal. Apart from the previous metadata mentioned, the groundwater depth is required for piezocone derivations. Dissipation tests may be done.

### 7.6. Proposed working CPT structure

The AGS 3.1 Format transfers CPT data in the STCN group. STCN is a child of Hole and has a keyset of Hole\_ID, STCN\_DPTH. Metadata such as STCN\_TYP (Cone test type) and STCN\_REF (Cone identification reference), and FILE\_FSET (Associated file reference) are repeated on each line of a push.

We consider the most appropriate working data structure to satisfy the 3 user groups consists of a parent table, which we will call STCG for this discussion, and the test data table that we will continue to call STCN. The STCG table has a keyset of HOLE\_ID, STCG\_TESN and would contain metadata on each push such as the data file name, calibrations, cone identifier, cone type, data required for derived parameter calculations, and possibly test date time and personnel. The STCN table would have a keyset of HOLE\_ID, STCG\_TESN, STCN\_DEP, and have fields for the recorded and derived parameters. Additional child tables of STCG store dissipation test results and data. Figure 6 shows the proposed table relationships and fields diagrammatically. HOLE\_ID, STCG\_TESN, STCN\_DEP correspond to PointID, ItemKey, and Depth, respectively. The GintRecID field is an internal key used by the database software and is not relevant to these issues.

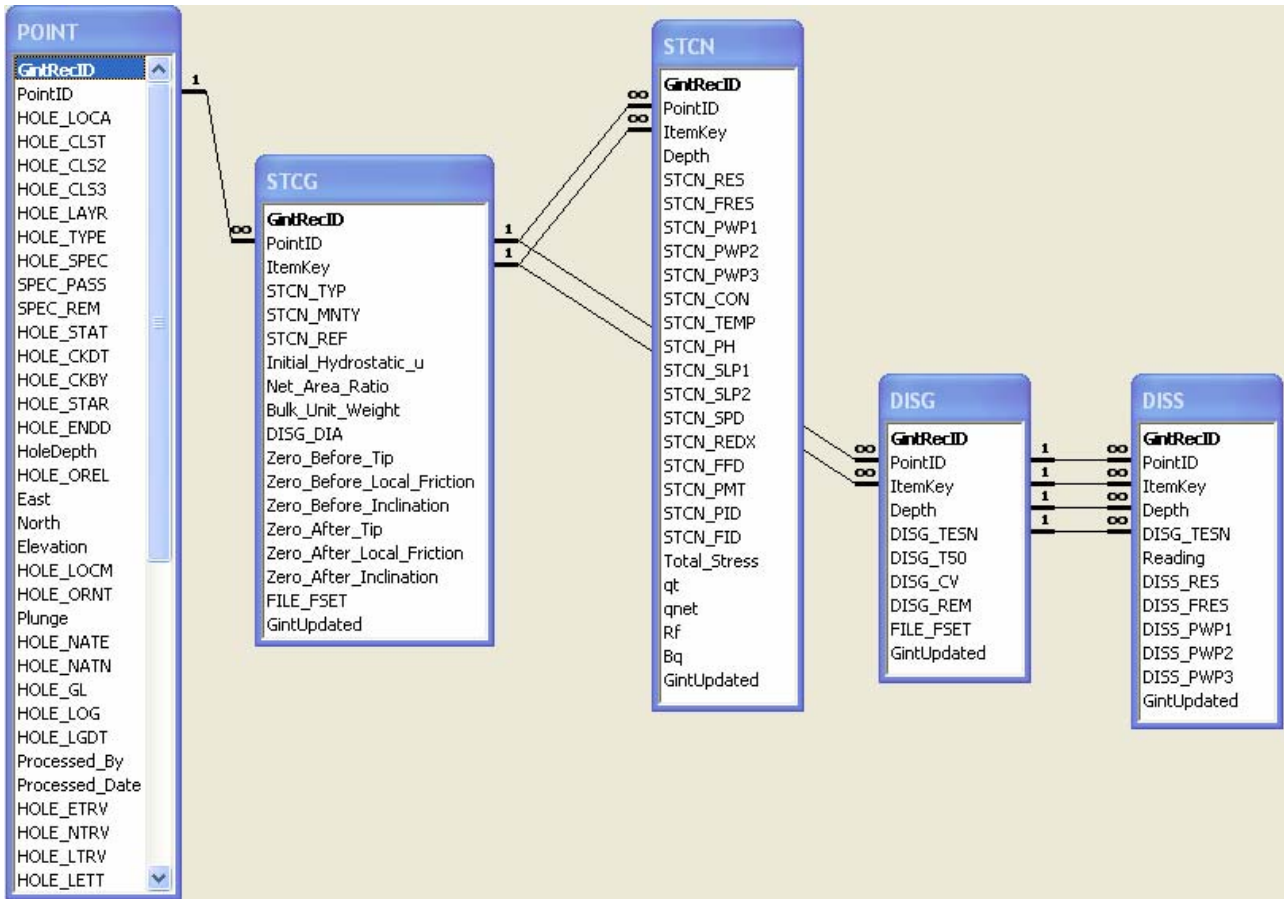


Figure 6. Relationship diagram for CPT data.

## 8. MONITORING DATA

### 8.1. Background

AGS-M was incorporated into AGS 3.1 adding, among others, the MONP and MONR groups. There are now two locations to transfer many types of monitoring data, hence a note states the new tables are to take precedent. It is also noted that many old monitoring tables will be deleted in the next version.

### 8.2. Practice

MONP and MONR have proven to be a useful structure for data transfer, but rather unfriendly structure of a working database for some standard geotechnical instruments. Database tables duplicating MONP and MONR have all the fields for deduced values that we consider are typically required. But if the required metadata fields and raw data fields were added for all the instrument types possible the tables would be come very large and unworkable as an input form. That is why each instrument class needs its own database table or tables and input forms.

Let us consider a number of instrument types.

### 8.3. Optical Settlement

This class of instrument falls under the AGS 3.1 MONP\_TYPE codes of TS and MSET and includes instruments such as:

- Surface settlement markers
- Total station points
- Rod settlement gauges

The AGS group relationship is compatible with how users want to enter and view the data. Generally these instruments need few additional metadata or raw data fields, the x, y, z and displacements are sufficient. A base reading needs to be identified for calculation of displacements. Additional calculated fields for the change since last reading, and raw reading fields for Rod Settlement Gauge may be useful as shown in Figure 7.

The screenshot shows a software window titled 'INPUT - e:\data\paper\monitoring example.gpj: MONP table Library: e:\data\paper\lib\_dev.glb'. The interface includes a menu bar (File, Edit, Format, Tables, gINT Rules, Navigation, Add-Ins, Help) and a toolbar. Below the toolbar are several tabs: INPUT, OUTPUT, REPORTS, SYMBOLS, DRAWINGS, DATA DESIGN, UTILITIES. A secondary set of tabs includes Main Group, Site Map, Surfaces, Depth Doc, CPT, Field Testing, Monitoring, Lab-Class, Lab-Comp Rel, Lab-Shear-Consol-Perm, Lab-Chem, Lab-Rock, Lab-... The 'Monitoring' tab is active, showing a list of monitoring groups: 1 Optical Settlement, 2 MSET & RSG Install, 3 Piezo, 4 ETM General, 5 ETM Surveys, 6 ZLT. The selected group is '[Monitoring group]'. Below this is a table with columns: Dist from Ref (m), Monitoring Point ID, Instrument Type, Ref Type, Bearing Axis A (deg), Bearing Axis B (deg), Bearing Axis C (deg), Inclination Axis A (deg), Inclination Axis B (deg), Inclination Axis C (deg), Sign Direction A, Sign Direction B, Sign Direction C. The data rows are: -0.1 Top Rod (MSET, INST, NA, NA, NA, NA, NA, 90, NA, NA, Displacement up) and 0 Fill Level (MSET, FILL, NA, NA, NA, NA, NA, 90, NA, NA, Displacement up). Below this table is a search bar with 'Name=MONP\_ID.' and 'Row 1 Of 2'. The second table is titled 'Monitoring Point Reading RSG, -0.1, Top Rod' and has columns: Date/Time of Reading (dd/mm/yyyy hhmmss), <= Displacement B (mm), Dis Change B (mm), Displacement C (mm), Dis Change C (mm), Easting (m), Northing (m), Bench Mark Elevation (m), Back Site (m), Height of Instrument (m), Front Site (m), Level (m), RSG Top Rod Elevation (m), Gauge Length (m), Logged By, Remarks. The data rows are: 01/06/2005 (5, -10), 02/06/2005 (-5, -10), 03/06/2005 (-15, -10), 04/06/2005 (-25, -10), 05/06/2005 (-35, -10), 06/06/2005 (-45, -10), 07/06/2005 (-55, -10). The 'Level' column values are 0.000, -0.010, -0.020, -0.030, -0.040, -0.050, -0.060. The 'RSG Top Rod Elevation' values are 3.000, 2.990, 2.980, 2.970, 2.960, 2.950, 2.940. The 'Gauge Length' values are 3.000, 3.000, 3.000, 3.000, 3.000, 3.000, 3.000. The 'Logged By' values are DH, JA, MJ, PMW, MM, MM. The 'Remarks' column is empty. The interface also shows 'Row 1 Of 7' at the bottom right.

Figure 7. Sample structure for optical settlement data.

#### 8.4. Standpipe Piezometer

This class of instrument falls under the AGS 3.1 MONP\_TYPE codes of SP (Standpipe) and SPIE (Standpipe Piezometer). The AGS group relationship is compatible with users viewing and data entry needs. However in reality, the depth to the water level may be taken from a point different than the Hole table datum, hence the metadata for the stickup must be stored, along with the raw depth reading that can be used to deduce the depth below the Hole table datum.

Many additional metadata fields for material types, aquifer name, and base readings could be in the parent table. Many additional calculated fields could be in the child table, such as water elevation, change since base reading and last reading, and water pressure. Figure 8 provides an example of some additional fields, some of which are grey fields indicating they are calculated from user defined formulas.

The screenshot shows a software interface for monitoring data. The main window title is "INPUT - e:\data\paper\monitoring example.gpj: PREF table". The interface includes a menu bar (File, Edit, Format, Tables, gINT Rules, Navigation, Add-Ins, Help) and a toolbar. Below the toolbar are several tabs: INPUT, OUTPUT, REPORTS, SYMBOLS, DRAWINGS, DATA DESIGN, UTILITIES. Underneath these are more specific tabs: Main Group, Site Map, Surfaces, Depth Doc, CPT, Field Testing, Monitoring (selected), Lab-Class, Lab-Comp Rel, Lab-Shear-Consol-Perm, Lab-Chem, Lab-Rock, Lab-... The "Monitoring" tab is active, showing a table with columns: Depth (m), Elevation of Tip (m), Stickup of Ref Point (m), Piezometer type, Response Zone Top Depth (m), Response Zone Top Elevation (m), Response Zone Base Depth (m), Response Zone Base Elevation (m), Remarks, Aquifer, Desc. Ref. Point, PVC Type, and Internal Dia PVC (mm). The data row shows: 10, -4.64, 0.28, SP, 1, 4.36, 10, -4.64, Remarks, Shallow, PC-TOC, PVC Type, 75. Below this is a section for "Piezo Readings" for "SP, 10". This section contains a table with columns: DateTime (dd/mm/yyyy hhmmss), Water Depth Below Ref Pt (m), Water Depth bgl (m), Water Head (m), Remarks, Water Elevation (m), Ch EL Since Base (m), Ch EL Since Previous (m), Pore Pressure (kPa), Base Reading, Logged By, Dipper ID, and Status. The data rows are: 06/07/2005 10:46:00, 5.36, 5.08, 4.92, 0.28, -0.01, 0.01, 49.4, 49.4, ABC, 3, I; 07/07/2005 10:52:00, 5.37, 5.09, 4.91, 0.27, -0.02, 0.01, 49.3, 49.3, ABC, 3, I; 08/07/2005 18:26:00, 5.34, 5.06, 4.94, 0.30, 0.01, 0.03, 49.6, 49.6, ABC, 3, I; 09/07/2005 10:22:00, 5.33, 5.05, 4.95, 0.31, 0.02, 0.01, 49.7, 49.7, ABC, 3, I; 10/07/2005 11:12:00, 5.35, 5.07, 4.93, 0.29, 0.00, -0.02, 49.5, 49.5, ABC, 3, I; 11/07/2005 11:04:00, 5.34, 5.06, 4.94, 0.30, 0.01, 0.01, 49.6, 49.6, ABC, 3, I; 12/07/2005 10:16:00, 5.37, 5.09, 4.91, 0.27, -0.02, -0.03, 49.3, 49.3, ABC, 3, I.

Figure 8. Sample structure for piezometer data.

### 8.5. Magnetic Extensometer

This is the AGS 3.1 MONP\_TYPE code ETM. The AGS MONP and MONR group and key structure is not user friendly for data entry, however it can be useful to view data for each target independently and is fine for data transfer (keeping in mind only the deduced displacement is transferred).

The problem is that all ETM targets (monitoring points) in a HOLE\_ID are read at the same Date and Time (MONR\_DATE & MONR\_TIME). This corresponds to an AGS keyset of HOLE\_ID, MONR\_DATE, MONR\_TIME, MONP\_DIS, MONP\_ID.

However, the AGS MONR group keyset is HOLE\_ID, MONP\_DIS, MONP\_ID, MONR\_DATE, MONR\_TIME. The data can be recorded in this keyset, but it is an inconvenient task because the user must swap between MONP records to enter the reading for each target.

We designed a working database with four tables for ETM data as defined in Figure 8; again, this example the key fields, among others, have non-AGS names. ETMG is a 1 to 1 child of HOLE/POINT and stores the metadata. ETMT defines a master list of the targets (ETMT) and these are used to pre-populate the reading table (ETMR) with the target identifiers for each survey date (defined in ETMS). This creates a user friendly data entry form. Then the raw readings may be entered and deduced to an elevation and displacement. Figures 9 and 10 show the user interface for this structure.

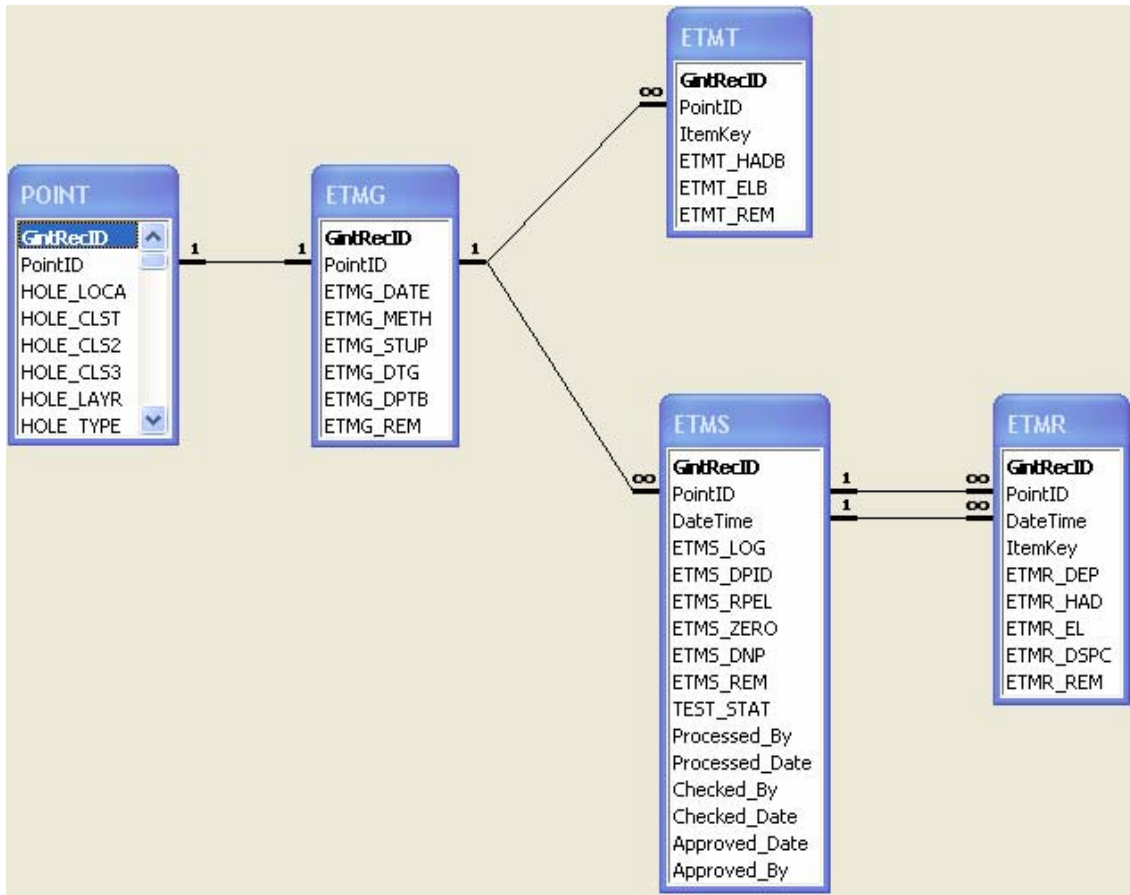


Figure 8. Relationship diagram for magnetic extensometer data

INPUT - e:\data\paper\monitoring example.gpj: Etm table Library: e:\data\paper\lib\_dev.glb

File Edit Format Tables gINT Rules Navigation Add-Ins Help

INPUT OUTPUT REPORTS SYMBOLS DRAWINGS DATA DESIGN UTILITIES

Main Group Site Map Surfaces Depth Doc CPT Field Testing Monitoring Lab-Class Lab-Comp Ref Lab-Shear-Consol-Perm Lab-Chem Lab-Rock Lab-M...

1 Optical Settlement 2 MSET & RSG Install 3 Piezo 4 ETM General 5 ETM Surveys 6 ZLT

[Monitoring group] Table Help

Hole ID	Calc Method	Stickup of Ref Point (m)	Datum Target ID	Base Reading Depth to Datum Target (m)	Remarks
ETM	Datum	0.338	9	14.886	

Row 1 Of 1

Extensometer Targets ETM Table Help

Target ID	Base Reading Height Above Datum	Base Reading EL (m)	Remark
1	11.816	2.615	
2	10.350	1.149	
3	8.914	-0.287	
4	7.464	-1.738	
5	5.955	-3.246	
6	4.459	-4.742	
7	2.933	-6.268	
8	1.454	-7.747	
9	0.000	-9.201	Datum magnet

Name=ETMT\_HADB. Row 1 Of 9

Figure 9. Sample structure for magnetic extensometer background data.

DateTime (dd/mm/yyyy hhmmss)	Logged By	Dipper ID	Ref Pt Elevation (m)	Base Survey	Do Not Print	Remark	Status	Processed By	Processed Date (dd/mm/yy)
10/08/2005	ABC	AR		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		3	ABC	11/08/200!
11/08/2005	ABC	AR		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		3	ABC	12/08/200!
12/08/2005	ABC	AR		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		3	ABC	13/08/200!
13/08/2005	ABC	AR		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		3	ABC	14/08/200!
14/08/2005	ABC	AR		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		3	ABC	15/08/200!
15/08/2005	ABC	AR		<input type="checkbox"/>	<input type="checkbox"/>		3	ABC	16/08/200!
16/08/2005	ABC	AR		<input type="checkbox"/>	<input type="checkbox"/>		3	ABC	17/08/200!
17/08/2005	ABC	AR		<input type="checkbox"/>	<input type="checkbox"/>		3	ABC	18/08/200!

Target ID	Depth Below Ref Pt (m)	Height Above Datum (m)	Elevation (m)	Displacement (mm)	Remark
1	3.071	11.815	2.614	-1	
2	4.535	10.351	1.150	1	
3	5.971	8.915	-0.286	1	
4	7.421	7.465	-1.736	1	
5	8.930	5.956	-3.245	1	
6	10.426	4.460	-4.741	1	
7	11.953	2.933	-6.268	0	
8	13.430	1.456	-7.745	2	
9	14.886	0.000	-9.201	0	

Figure 10. Sample structure for magnetic extensometer data

## 9. SUMMARY

Given the tremendous cost to generate data and the importance of quality information, a properly designed database specifically configured to meet all project needs, not just interchange requirements, is crucial for efficient and quality data operations. Interchange specifications must be met but they need to be secondary design considerations, not primary.

## 10. REFERENCES

The Association of Geotechnical and Geoenvironmental Specialists (2005), "Electronic Transfer of Geotechnical and Geoenvironmental Data, (Edition 3.1) including addendum May 2005"

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