# THE RHIC TRANSFER LINE CABLE DATABASE *

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Abstract

A cable database was created to facilitate and document installation of cables and wiring in the RHIC project, as well as to provide a data source to track possible wiring and signal problems. The eight tables of this relational database, currently implemented in Sybase, contain information ranging from cable routing to attenuation of individual wires. This database was created in a hierarchical scheme under the assumption that cables contain wires — each instance of a cable has one to many wires associated with it. This scheme allows entry of information pertinent to individual wires while only requiring single entries for each cable. Relationships to other RHIC databases are also discussed.

## I. INTRODUCTION AND SCOPE

The RHIC project consists of the pre-existing Booster and AGS as an ion injector complex, the AGS-to-RHIC (ATR) transfer lines and the main RHIC rings. The ongoing construction of the transfer line and collider provides an opportunity to design and fill project databases to track and relate pertinent information regarding the installation of equipment. One such database is the *atr_cable* database, which describes the cabling and wiring of the ATR line of the RHIC project. A separate database to serve this purpose for the main RHIC rings is currently under design.

During construction, a need for an organized, centrally located database to assist in the installation of cables and the "wire-up" of devices was recognized. The original motivation for the *atr_cable* database was to improve and streamline the tracking of signal and ground faults for ATR beam position monitors (BPMs) by the RHIC instrumentation group. The scope has grown, however, and the *atr_cable* database is now being used by all RHIC groups involved in installation of cables and wires in the ATR line.

Cables are defined as the jackets that surround one or many conductors, or wires. Cables and wires are usually, but do not have to be, two different things — in the case of a single-conductor cable, the cable and wire are physically the same. For the purposes of this database, such a single-conductor cable has two separate names, one indicating it is a cable and another indicating it is a wire. There is a one-to-many relationship between cables and wires.

The main objective of the installation section of the database project is two-fold: unique names are needed for the cables and wires in the ATR transfer line, and reports are required for installation. These reports are also used as check lists to record which cables and wires have already been installed. When each cable is pulled and cut for installation, it is labeled with the Brady Cable Labeling system (a small computer that generates labeling sleeves with the unique cable names for permanent tagging) using data generated from this database. Some individual wires are also labeled in this manner.

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## II. DATABASE DESIGN

Figure 1 shows the structure of the *atr_cable* database as developed using ERDRAW [1], a graphical extended entity-relationship database tool. The internal compositions and a few sample entries for the two primary tables, Cables and Wires, are shown in Tables I and II respectively.

An entity-relationship (ER) diagram consists of three types of figures: rectangles, rhombi, and arcs. Rectangles represent objects, or "entities", and are implemented as tables in the database — each table entry, or row, is an object instance. For each entity table, a group of columns is specified as a "primary key" or unique identifier for each table entry. These groups of columns are specified with ** in Tables I and II.

Rhombi in Figure 1 are called "relationships" and represent associations between entities; these too are implemented as database tables. These relationships may be one-to-one, one-to-many or many-to-many mappings. As discussed in the next section, the Found_By relationship is many-to-many and the Implies relationship is one-to-many.

Arcs indicate referential integrity constraints, including key inheritance and update triggers. They further define the relationship between tables through the arc designations. For example, the arc designation *ID* leads to a referential integrity constraint that incorporates the primary key columns of the Keys table into the Cables and Wires tables automatically. Relational database procedures, created automatically by ERDRAW in the SQL language, enforce referential integrity during data entry by allowing entry of data into the Cables and Wires tables only when there is first a corresponding entry in the Keys table.

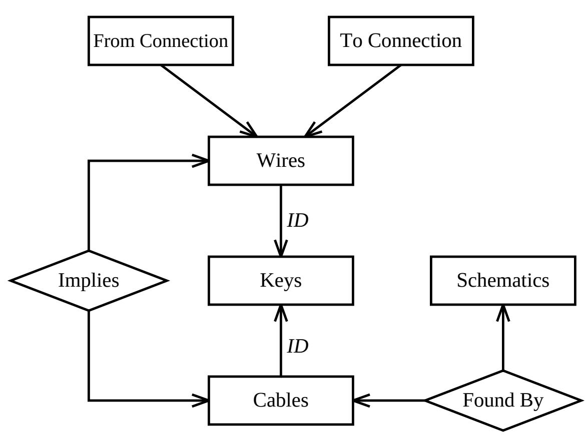


Figure. 1. An entity-relationship diagram of the RHIC *atr_cable* database, as diagramed with ERDRAW. Rectangles represent entity tables while rhombi represent relationship tables. Further details are in sections II an III of the text.

| SWN** | CD** | Type* | Length | Total Feet | Attenuation | Reel Number* | Tray | ... |
|---|---|---|---|---|---|---|---|---|
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| yd25 | c2 | 1pr#18–600V | 41 | NULL | NULL | TBD | 2 | |
| yd25 | c3 | 3pr#18–600V | 41 | NULL | NULL | 212 | 3b | |
| yd26 | c1 | 4pr#18–shld | 33 | NULL | NULL | TBD | NULL | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |

Table I

The *atr_cable* database Cables table — no null entries are permitted in columns marked with *, and ** demarcated columns (SWN, CD) comprise the table's unique primary key. Each entry represents a single physical cable in the RHIC ATR line with cable-specific attributes.

| SWN** | CD** | WD** | Voltage Class | Electrical Length | Status | Remarks | Conductor Size* | Conductor # or Color* |
|---|---|---|---|---|---|---|---|---|
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| yd25 | c1 | 7 | TBD | NULL | Installed | NULL | NA | green |
| yd25 | c1 | 8 | TBD | NULL | Installed | NULL | NA | black |
| yd25 | c2 | 1 | TBD | NULL | Not Inst. | NULL | NA | white/blue |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |

Table II

The *atr_cable* Wires table. Each entry represents a single wire (conductor or signal-carrying component) within cables in the RHIC ATR line.

## III. TABLE DETAILS

The RHIC project has adopted use of a "SiteWide Name" (SWN) as a unique designator for each primary equipment slot; this is different than an equipment serial number which refers to the particular instance of equipment installed within that slot. SiteWide Names are a natural component of unique identifiers for cables and wires, where by convention the SWN of the equipment *from* which the signal carried by the cable or wire travels is used. SiteWide Names also are used as primary indices in many other RHIC databases describing beam optics layout, hardware installation and controls configuration information[2], which provides a consistent language with which to develop the entire RHIC database design.

The Keys table contains two attributes or columns — a SWN and a Cable Designator (CD). The combination of these two attributes results in a unique primary key for each cable in the ATR line; this table thus acts as a base repository for valid primary key designations. The arc-label 'ID' leads to a referential integrity constraint discussed above that incorporates the primary key of the Keys table in the Cables and Wires tables.

The primary key for the Cables table is the same as for the Keys table, a unique combination of SWN and CD. This key thus serves as a singular identifier for every cable within the transfer line complex. The Cables table also contains other information about cables, such as their length in feet, the reel number(s) from which the cables are pulled (a mandatory entry with a default of "TBD" — To Be Determined), and the tray used for installation, as well as others. Table I shows this table with three entries for cables running from Y-line dipole 25.

The primary key for the Wires table includes the primary key from the Keys table, as well as an additional Wire Designator (WD). The WD gives a unique name to each wire or conductor contained within each cable. The WD is the last part of the hierarchical naming scheme, and every table in the database has a reference to either the (SWN, CD) combination to specify a cable, or the (SWN, CD, WD) combination to specify a wire. Also included in the Wires table is wire-specific information such as voltage class, electrical length, conductor size and color. Table II shows the Wires table, with component wire entries for the cables listed in Table I.

The Implies table is a relationship between the Cables and Wires tables with a one-to-many mapping which provides a direct charting of the relationship between each cable and each wire. This table provides an explicit listing of wires comprising each cable, and serves as another internal consistency check.

The From_ and To_Connection tables provide the most detailed routing information for the wires in the ATR line. These keep track of the specific connections, or spigots, on devices such as bus bars and magnets to and from which a wire leads.

The Schematics table has columns listing which equipment group is responsible for each cable, which schematic number a cable is on (the primary key) as well as the revision and revision date of the given schematic. The Found_By table maintains referential integrity between Cables and Schematics, mapping between a list of cables in the Cables table and the schematics on which the cables are found.

## IV. DATABASE USAGE EXAMPLES

After installation, all of the cabling and wiring information for the ATR line will be contained in this database. Data entry is proceeding using the generic Sybase data workbench (dwb) tool[3], and recently the InfoMaker package[4] has been acquired to to implement a form-based data entry system.

As mentioned earlier, this information will be useful in future tracking of signal and ground faults, in conjunction with the wireup database[5]. The wireup database is a repository for a generic wireup scheme describing hierarchical and connection relationships between accelerator subsystems. Using this general scheme in conjunction with the specific instances described in the *atr_cable* database, one can fully trace the routing of all cables and wires in the entire ATR line in an online database.

A simpler example of *atr_cable* database usage is when a wire comes loose from a connection. Rather than having to find the proper schematic associated with the wire, reconnection can be done simply either by use of the label on that particular wire or with a simple SQL database query. For example, `select * from To_Connection where SWN = yd25 and CD = c2` will respond with a list of all the wire connections for the second cable connected to the magnet named `yd25`.

Other examples of useful SQL queries to this database include:

1. To find all cables connected to device **D**:
```
select SiteWideName, CableDesignator
from Cables
where SiteWideName = 'D'
```
2. To list all wires not yet installed:
```
select SiteWideName, CableDesignator,
WireDesignator
from Wires
where Status = 'NI'
```
3. To list all cables on schematic **S**:
```
select *
from FoundBy
where DrawingNumber = 'S'
```

## V. SUMMARY AND CONCLUSIONS

This paper describes the current structure of the *atr_cable* database, including two applications covering installation, and online and offline routing diagnosis. Implementation of data entry and use for cable installation procedures is ongoing. This database is a dynamic system in that the data structures are changing as new requirements arise. As of present, all information requested by installation and instrumentation groups has been implementable within this design. A RHIC cable database based on these tables is currently in design stages.

**Acknowledgments**

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## VI. REFERENCES

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