An Historic Document (but not a relic) – IEEE C37.2 Standard Electrical Power Device Function Numbers, *Acronyms*, and Contact Designations

There are few IEEE standards in active use today that can trace their roots back to the 1920s, but that is certainly the case with IEEE C37.2. Quoting from its *Introduction*, "The original work on this subject was approved in 1928 and published by the American Institute of Electrical Engineers (AIEE) as AIEE No. 26".
This historic document was recently updated by a joint working group of PES Substations and Power System Relaying Committees. Many of the "device function numbers" that appear in the 2008 update of IEEE C37.2 date back to that original version. So what was the motivation, in the 1920s, to create such a standard? It was the compelling need to create a simple, easily understood means to describe all the devices in the "automatic substations" of that era. (see photos. The dc elementary diagrams in this 1924 brochure contain many of the function numbers still in C37.2 today!) These substations contained mulitple (two, three, four or more) synchronous converters that converted ac to 600 volts dc for street cars and interurban transit. With the logic entirely contained within the electromechanical relays and timers, the control systems in these unattended stations responded to increasing dc load by starting (at reduced voltage – then full voltage) and placing on line added rotary converters – but in a sequence such that the same unit was not always first.

The foundation bulding block of these control systems *was* "Device number 1 – master element -A device, such as a control switch, etc. that serves, either directly or through such permissive devices as protective and time-delay relays, to place equipment in or out of operation." Device number 2 *was* "time delay starting or closing relay", Device number 3 *was* "checking or interlocking relay", Device number 6 *was* "starting circuit breaker", Device number 10 *was* "unit sequence switch – a device that is used to change the sequence in which units may be placed in or out of service in multiple-unit equipment." Note the use of the word "*was*". The *was* word is correct, but it certainly leaves the wrong impression, as these exact descriptions are still in the 2008 update of IEEE C37.2.

Device number 34 – *master sequence device* was one of the original device numbers, and now has an updated description "A device such as a motor operated multi-contact switch, or the equivalent, or a programmable device, that establishes or determines the operating sequence of the major devices in equipment during starting or stoppinig or during sequential switching operation." But device 34 was in the 1928 original.

Another veteran is Device number 82 – *dc load-measuring reclosing relay* "A device that controls the automatic closing and reclosing of a dc circuit interrupter, generally in response to load circuit conditions." This device, along with device number 7 – rate-of-change relay, is an example of the innovative application of electromechanical technology many years ago. Many of us who attended the PES General Meeting last June in Tampa, FL rode the street car to Yuba City. These cars have the original motorman (that's what they were called) manually operated controller. As the motorman rotates the operating handle of the master controller,, at first dc is applied to the shunt field of the traction motors – but through a tapped resistor to control the inrush. Next dc is applied to the armature, again through a resistor to limit inrush. As the traction motors' dc fields build up, their counter emf causes the current to decrease, so the motorman can then rotate the controller handle to the next "notch". If he rotated the controller handle too

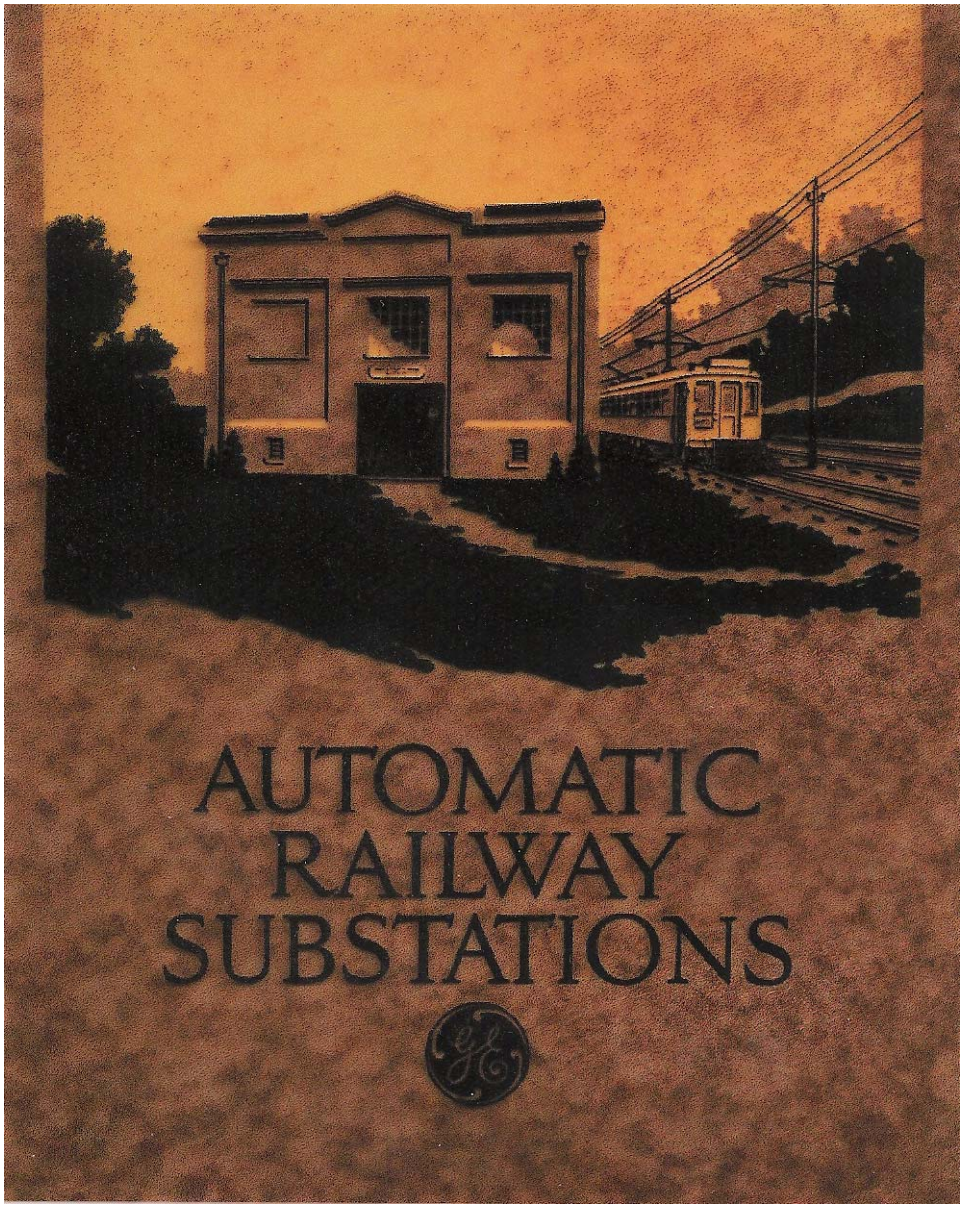
rapidly, the current in that trolley circuit would exceed the load setting of the device 82. But the rate of rise was not that of a fault. The rate of rise on the trolley circuit was monitored by a device number 7 – "a device that operates when the rate-of-change of the measured quantity exceeds a threshold value - - -". So if device 82 operated and device 7 did not, reclosing took place. On the other hand, if a fault occurred, the rate of change of the current would be very high, and device 7 would trip the dc breaker serving that circuit and block relosing. And all this was done with electromechanical relays!

In the 1920s, each manufacture had its own method of describing their automatic substations, and none were exactly alike. The following pages were copied from the 1924 GE Bulletin 44092C. The elementary diagram shows examples of the GE version of device numbers. So AIEE took on the task of bringing some clarity to this "Tower of Babel", and ultimately AIEEE No. 26 was published in 1928.

It is interesting to note that the "Standard Handbook for Electrical Engineers – Eighth Edition" published in 1949, after a discussion of automatic substations, includes this paragraph in Section 12 "Power System Electrical Equipment", subsection "Control Switchboards" which reads: **Automatic equipment**, with standard device numbers for the various relays and devices, has been extensively standardized by the various manfacturters and is available for different equipment and functions. See Figure 12-185. It has sometimes been applied in whole or in part to equipment in attended stations to relieve the operator for other duties and to reduce the possibilies of operating errors."

However, even though it had been twenty years since AIEE No. 26 was published the editors must have been overly cautious as Figure 12-185 does not include a single function number. Even though an ac circuit breaker icon is shown on the diagram, not even it is labled a device 52! But the numbers were being used! The GE relay catalog in those days included a full page of all the then current device function numbers, and each realy page included its C37.2 device fucntion number the AC time overcurrent relay page showed it was a device 51, etc.

Since its original issue, this standard has been revised and updated as needs arose. For exaple, in the 1960's, unit connected generator stepup transformers were failing due to over-excitation (tthe generator field was being applied when the unit was on turning gear and the generator voltage regulator was not disabled). The result was over exciation, and a new relay and function number - volts per Hertz funcion number were created. During the 2007-2008 update effort, we learned through an Email survey (conducted for the PES Substations working group by IEEE Strategic Planning) that essentailly all the old function numbers dateing back to AIEE 26 were still in use, but there were at least fifteen new function numbers needed. The solution was to use acronyms for those new functions. So the 2008 edition of C37.22 is now titled IEEE C37.2 Standard for Electrical Power Device Funtion Numbers, Acronyms, and Contact Designations and includes seventeen acronyms. They are AFD – Arc Flash Detector, CLK – Clock or timing source, DDR – Dynamic Disturbance Recorder, DFR – Digital Fault Recorder, ENV – Environmental data, HIZ – High Impedance Fault Detector, HMI – Human Machine Interface, HST – Historian, LGC – Scheme logic (the function, as in a RAS– not a device like a PLC), MET – Substation Metering, PDC – Phasor Data Concentrator, PMU – Phasor Measurement Unit (the function), PQM – Power Quality Monitor, RIO - Remote Input/Output Device, RTU – Remote Terminal Unit / Data Concentrator, SER – Sequence of Events Recorder, TCM – Trip Circuit Monitor (the red light function remoted). Be sure to let the PES Substations Committee know if there are other additions needed.



AUTOMATIC RAILWAY SUBSTATIONS

Evans Avenue Substation of the United Railways of St. Louis showing Automatic Control and Reclosing Feeders for Two 1000 KW Synchronous Converters (circa 1924)

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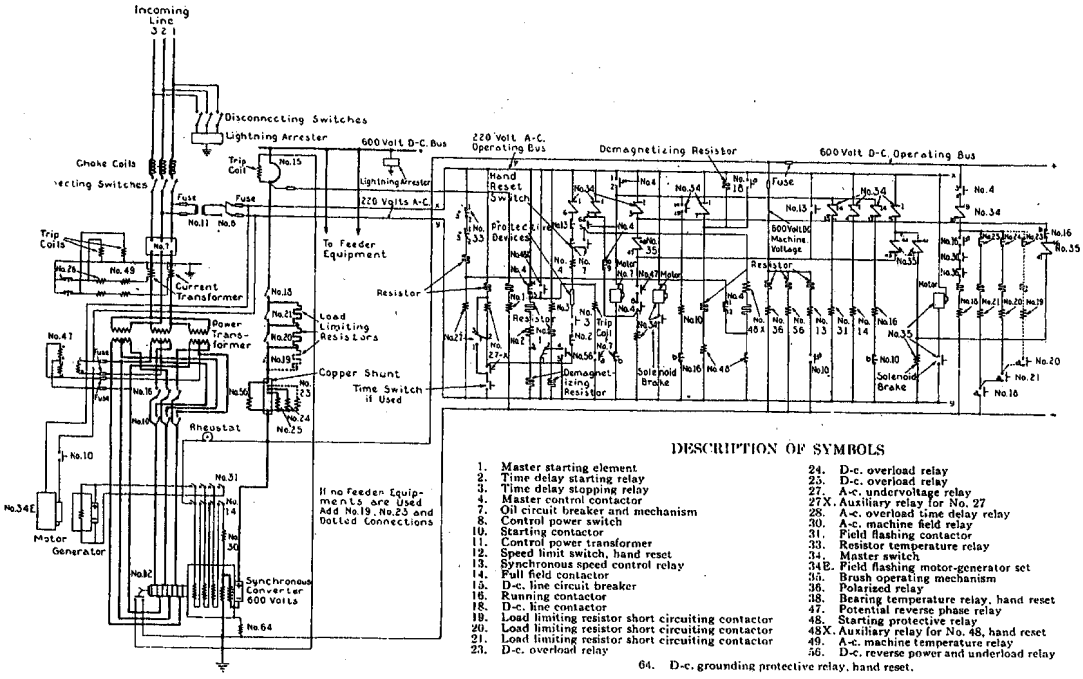
AUTOMATIC RAILWAY SUBSTATIONS

GENERAL ELECTRIC COMPANY
SCHENECTADY, NEW YORK

SEPTEMBER, 1924

BULLETIN No. 44092C
Supersedes No. 44092B

Data subject to change without notice
Class 15



DESCRIPTION OF SYMBOLS

1. Master starting element
2. Time delay starting relay
3. Time delay stopping relay
4. Master control contactor
7. Oil circuit breaker and mechanism
8. Control power switch
10. Starting contactor
11. Control power transformer
12. Speed limit switch, hand reset
13. Synchronous speed control relay
14. Full field contactor
15. D-c. line circuit breaker
16. Running contactor
18. D-c. line contactor
19. Load limiting resistor short circuiting contactor
20. Load limiting resistor short circuiting contactor
21. Load limiting resistor short circuiting contactor
23. D-c. overload relay
24. D-c. overload relay
25. D-c. overload relay
27. A-c. undervoltage relay
27X. Auxiliary relay for No. 27
28. A-c. overload time delay relay
30. A-c. machine field relay
31. Field flashing contactor
33. Resistor temperature relay
34. Master switch
34E. Field flashing motor-generator set
35. Brush operating mechanism
36. Polarized relay
38. Bearing temperature relay, hand reset
47. Potential reverse phase relay
48. Starting protective relay
48X. Auxiliary relay for No. 48, hand reset
49. A-c. machine temperature relay
56. D-c. reverse power and underload relay
64. D-c. grounding protective relay, hand reset.

WIRING DIAGRAM OF TYPICAL AUTOMATIC SUBSTATION