



The devices in switching equipments are referred to by numbers, with appropriate suffix letters (when necessary) according to the functions they perform. These numbers are based on a system which has been adopted as standard for automatic switchgear

by AIEE and incorporated in American Standard C37.2—1956. This system is used on connection diagrams, in instruction books, and in specifications. Device numbers recommended by AIEE for Pipeline Pump Stations are given on pages 8-12, inclusive.

device number	definition and function
1	<b>master element</b> is the initiating device, such as a control switch, voltage relay, float switch, etc., which serves either directly, or through such permissive devices as protective and time-delay relays to place an equipment in or out of operation.
2	<b>time-delay starting, or closing, relay</b> is a device which functions to give a desired amount of time delay before or after any point or operation in a switching sequence or protective relay system, except as specifically provided by device functions 62 and 79 described later
3	<b>checking or interlocking relay</b> is a device which operates in response to the position of a number of other devices, or to a number of predetermined conditions in an equipment to allow an operating sequence to proceed, to stop, or to provide a check of the position of these devices or of these conditions for any purpose.
4	<b>master contactor</b> is a device, generally controlled by device No. 1 or equivalent, and the necessary permissive and protective devices, which serves to make and break the necessary control circuits to place an equipment into operation under the desired conditions and to take it out of operation under other or abnormal conditions.
5	<b>stopping device</b> functions to place and hold an equipment out of operation.
6	<b>starting circuit breaker</b> is a device whose principal function is to connect a machine to its source of starting voltage.
7	<b>anode circuit breaker</b> is one used in the anode circuits of a power rectifier for the primary purpose of interrupting the rectifier circuit if an arc back should occur.
8	<b>control power disconnecting device</b> is a disconnecting device—such as a knife switch, circuit breaker or pullout fuse block—used for the purpose of connecting and disconnecting, respectively, the source of control power to and from the control bus or equipment.  <small>note: Control power is considered to include auxiliary power which supplies such apparatus as small motors and heaters.</small>

device number	definition and function
9	<b>reversing device</b> is used for the purpose of reversing a machine field or for performing any other reversing functions.
10	<b>unit sequence switch</b> is used to change the sequence in which units may be placed in and out of service in multiple-unit equipments.
11	Reserved for future application.
12	<b>over-speed device</b> is usually a direct-connected speed switch which functions on machine overspeed.
13	<b>synchronous-speed device</b> , such as a centrifugal-speed switch, a slip-frequency relay, a voltage relay, an undercurrent relay or any type of device, operates at approximately synchronous speed of a machine.
14	<b>under-speed device</b> functions when the speed of a machine falls below a predetermined value.
15	<b>speed or frequency, matching device</b> functions to match and hold the speed or the frequency of a machine or of a system equal to, or approximately equal to, that of another machine, source or system.
16	Reserved for future application.
17	<b>shunting or discharge switch</b> serves to open or to close a shunting circuit around any piece of apparatus (except a resistor), such as a machine field, a machine armature, a capacitor or a reactor.  <small>note: This excludes devices which perform such shunting operations as may be necessary in the process of starting a machine by devices 6 or 42, or their equivalent, and also excludes device 73 function which serves for the switching of resistors.</small>
18	<b>accelerating or decelerating device</b> is used to close or to cause the closing of circuits which are used to increase or to decrease the speed of a machine.
19	<b>starting-to-running transition contactor</b> is a device which operates to initiate or cause the automatic transfer of a machine from the starting to the running power connection.

▲ Refer to proposed supplement pages 8 to 12, inclusive.

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device number	definition and function	device number	definition and function
<b>20</b>	<b>electrically operated valve</b> is a solenoid- or motor-operated valve which is used in vacuum, air, gas, oil, water, or similar lines.  <b>note:</b> The function of the valve may be indicated by the insertion of descriptive words such as "Brake" or "Pressure Reducing" in the function name, such as "Electrically Operated Brake Valve".	<b>30</b>	<b>annunciator relay</b> is a nonautomatically reset device which gives a number of separate visual indications upon the functioning of protective devices, and which may also be arranged to perform a lock-out function.
<b>21</b>	<b>distance relay</b> is a device which functions when the circuit admittance, impedance or reactance increases or decreases beyond predetermined limits.	<b>31</b>	<b>separate excitation device</b> connects a circuit such as the shunt field of a synchronous converter to a source of separate excitation during the starting sequence; or one which energizes the excitation and ignition circuits of a power rectifier.
<b>22</b>	<b>equalizer circuit breaker</b> is a breaker which serves to control or to make and break the equalizer or the current-balancing connections for a machine field, or for regulating equipment, in a multiple-unit installation.	<b>32</b>	<b>directional power relay</b> is one which functions on a desired value of power flow in a given direction, or upon reverse power resulting from arc back in the anode or cathode circuits of a power rectifier.
<b>23</b>	<b>temperature control device</b> functions to raise or to lower the temperature of a machine or other apparatus, or of any medium, when its temperature falls below, or rises above, a predetermined value.  <b>note:</b> An example is a thermostat which switches on a space heater in a switchgear assembly when the temperature falls to a desired value as distinguished from a device which is used to provide automatic temperature regulation between close limits and would be designated as 90T.	<b>33</b>	<b>position switch</b> makes or breaks contact when the main device or piece of apparatus, which has no device function number, reaches a given position.
<b>24</b>	Reserved for future application.	<b>34</b>	<b>motor-operated sequence switch</b> is a multi-contact switch which fixes the operating sequence of the major devices during starting and stopping, or during other sequential switching operations.
<b>25</b>	<b>synchronizing or synchronism-check device</b> operates when two a-c circuits are within the desired limits of frequency, phase angle or voltage, to permit or to cause the paralleling of these two circuits.	<b>35</b>	<b>brush-operating, or slip-ring short-circuiting, device</b> is used for raising, lowering, or shifting the brushes of a machine, or for short-circuiting its slip rings, or for engaging or disengaging the contacts of a mechanical rectifier.
<b>26</b>	<b>apparatus thermal device</b> functions when the temperature of the shunt field or the armature winding of a machine, or that of a load limiting or load shifting resistor or of a liquid or other medium exceeds a predetermined value; or if the temperature of the protected apparatus, such as a power rectifier, or of any medium decreases below a predetermined value.	<b>36</b>	<b>polarity device</b> operates or permits the operation of another device on a predetermined polarity only.
<b>27</b>	<b>undervoltage relay</b> is a device which functions on a given value of undervoltage.	<b>37</b>	<b>undercurrent or underpower relay</b> is a device which functions when the current or power flow decreases below a predetermined value.
<b>28</b>	Reserved for future application.	<b>38</b>	<b>bearing protective device</b> is one which functions on excessive bearing temperature, or on other abnormal mechanical conditions, such as undue wear, which may eventually result in excessive bearing temperature.
<b>29</b>	<b>isolating contactor</b> is used expressly for disconnecting one circuit from another for the purposes of emergency operation, maintenance, or test.	<b>39</b>	Reserved for future application.
		<b>40</b>	<b>field relay</b> is a device that functions on a given or abnormally low value or failure of machine field current, or on an excessive value of the reactive component of armature current in an a-c machine indicating abnormally low field excitation.

# AIEE device numbers and functions for switchgear apparatus

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device number	definition and function	device number	definition and function
<b>41</b>	<b>field circuit breaker</b> is a device which functions to apply, or to remove, the field excitation of a machine.	<b>52</b>	<b>a-c circuit breaker</b> is a device which is used to close and interrupt an a-c power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.
<b>42</b>	<b>running circuit breaker</b> is a device whose principal function is to connect a machine to its source of running voltage after having been brought up to the desired speed on the starting connection.	<b>53</b>	<b>exciter or d-c generator relay</b> is a device which forces the d-c machine field excitation to build up during starting or which functions when the machine voltage has built up to a given value.
<b>43</b>	<b>manual transfer or selector device</b> transfers the control circuits so as to modify the plan of operation of the switching equipment or of some of the devices.	<b>54</b>	<b>high-speed d-c circuit breaker</b> is a device which starts to reduce the current in the main circuit in 0.01 second or less, after the occurrence of the d-c overcurrent or the excessive rate of current rise.
<b>44</b>	<b>unit sequence starting relay</b> is a device which functions to start the next available unit in a multiple-unit equipment on the failure or on the non-availability of the normally preceding unit.	<b>55</b>	<b>power factor relay</b> is a device which operates when the power factor in an a-c circuit becomes above or below a predetermined value.
<b>45</b>	Reserved for future application.	<b>56</b>	<b>field application relay</b> is a device which automatically controls the application of the field excitation to an a-c motor at some predetermined point in the slip cycle.
<b>46</b>	<b>reverse-phase, or phase-balance, current relay</b> is a device which functions when the polyphase currents are of reverse-phase sequence, or when the polyphase currents are unbalanced or contain negative phase-sequence components above a given amount.	<b>57</b>	<b>short-circuiting or grounding device</b> is a power or stored energy operated device which functions to short-circuit or to ground a circuit in response to automatic or manual means.
<b>47</b>	<b>phase-sequence voltage relay</b> is a device which functions upon a predetermined value of polyphase voltage in the desired phase sequence.	<b>58</b>	<b>power rectifier misfire relay</b> is a device which functions if one or more of the power rectifier anodes fails to fire.
<b>48</b>	<b>incomplete sequence relay</b> is a device which returns the equipment to the normal, or off, position and locks it out if the normal starting, operating or stopping sequence is not properly completed within a predetermined time.	<b>59</b>	<b>overvoltage relay</b> is a device which functions on a given value of overvoltage.
<b>49</b>	<b>machine, or transformer, thermal relay</b> is a device which functions when the temperature of an a-c machine armature, or of the armature or other load carrying winding or element of a d-c machine, or converter or power rectifier or power transformer (including a power rectifier transformer) exceeds a predetermined value.	<b>60</b>	<b>voltage balance relay</b> is a device which operates on a given difference in voltage between two circuits.
<b>50</b>	<b>instantaneous overcurrent, or rate-of-rise relay</b> is a device which functions instantaneously on an excessive value of current, or on an excessive rate of current rise, thus indicating a fault in the apparatus or circuit being protected.	<b>61</b>	<b>current balance relay</b> is a device which operates on a given difference in current input or output of two circuits.
<b>51</b>	<b>a-c time overcurrent relay</b> is a device with either a definite or inverse time characteristic which functions when the current in an a-c circuit exceeds a predetermined value.	<b>62</b>	<b>time-delay stopping or opening relay</b> is a time-delay device which serves in conjunction with the device which initiates the shutdown, stopping, or opening operation in an automatic sequence.
		<b>63</b>	<b>liquid or gas pressure, level, or flow relay</b> is a device which operates on given values of liquid or gas pressure, flow or level, or on a given rate of change of these values.

▲ Refer to proposed supplement, pages 8 to 12, inclusive.



device number	definition and function	device number	definition and function
64	<p><b>ground protective relay</b> is a device which functions on failure of the insulation of a machine, transformer or of other apparatus to ground, or on flash-over of a d-c machine to ground.</p> <p><b>note:</b> This function is assigned only to a relay which detects the flow of current from the frame of a machine or enclosing case or structure of a piece of apparatus to ground, or detects a ground on a normally ungrounded winding or circuit. It is not applied to a device connected in the secondary circuit or secondary neutral of a current transformer, or current transformers, connected in the power circuit of a normally grounded system.</p>	73	<p><b>load-resistor contactor</b> is used to shunt or insert a step of load limiting, shifting, or indicating resistance in a power circuit, or to switch a space heater in circuit, or to switch a light, or regenerative, load resistor of a power rectifier or other machine in and out of circuit.</p>
65	<p><b>governor</b> is the equipment which controls the gate or valve opening of a prime mover.</p>	74	<p><b>alarm relay</b> is a device other than an annunciator, as covered under device No. 30, which is used to operate, or to operate in connection with, a visual or audible alarm.</p>
66	<p><b>notching or jogging device</b> functions to allow only a specified number of operations of a given device, or equipment, or a specified number of successive operations within a given time of each other. It also functions to energize a circuit periodically, or which is used to permit intermittent acceleration or jogging of a machine at low speeds for mechanical positioning.</p>	75	<p><b>position changing mechanism</b> is the mechanism which is used for moving a removable circuitbreaker unit to and from the connected, disconnected, and test positions.</p>
67	<p><b>a-c directional overcurrent relay</b> is a device which functions on a desired value of a-c overcurrent flowing in a predetermined direction.</p>	76	<p><b>d-c overcurrent relay</b> is a device which functions when the current in a d-c circuit exceeds a given value.</p>
68	<p><b>blocking relay</b> is a device which initiates a pilot signal for blocking or tripping on external faults in a transmission line or in other apparatus under predetermined conditions, or co-operates with other devices to block tripping or to block reclosing on an out-of-step condition or on power swings.</p>	77	<p><b>pulse transmitter</b> is used to generate and transmit pulses over a telemetering or pilot-wire circuit to the remote indicating or receiving device.</p>
69	<p><b>permissive control device</b> is generally a two-position, manually operated switch which in one position permits the closing of a circuit breaker, or the placing of an equipment into operation, and in the other position prevents the circuit breaker or the equipment from being operated.</p>	78	<p><b>phase angle measuring, or out-of-step protective relay</b> is a device which functions at a predetermined phase angle between two voltages or between two currents or between voltage and current.</p>
70	<p><b>electrically operated rheostat</b> is a rheostat which is used to vary the resistance of a circuit in response to some means of electrical control.</p>	79	<p><b>a-c reclosing relay</b> is a device which controls the automatic reclosing and locking out of an a-c circuit interrupter.</p>
71	Reserved for future application.	80	Reserved for future application.
72	<p><b>d-c circuit breaker</b> is used to close and interrupt a d-c power circuit under normal conditions or to interrupt this circuit under fault or emergency conditions.</p>	81	<p><b>frequency relay</b> is a device which functions on a predetermined value of frequency—either under or over or on normal system frequency—or rate of change of frequency.</p>
		82	<p><b>d-c reclosing relay</b> is a device which controls the automatic closing and reclosing of a d-c circuit interrupter, generally in response to load circuit conditions.</p>
		83	<p><b>automatic selective control or transfer relay</b> is a device which operates to select automatically between certain sources or conditions in an equipment, or performs a transfer operation automatically.</p>

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device number	definition and function
84	<b>operating mechanism</b> is the complete electrical mechanism or servo-mechanism, including the operating motor, solenoids, position switches, etc., for a tap changer, induction regulator or any piece of apparatus which has no device function number.
85	<b>carrier or pilot-wire receiver relay</b> is a device which is operated or restrained by a signal used in connection with carrier-current or d-c pilot-wire fault directional relaying.
86	<b>locking-out relay</b> is an electrically operated hand or electrically reset device which functions to shut down and hold an equipment out of service on the occurrence of abnormal conditions.
87	<b>differential protective relay</b> is a protective device which functions on a percentage or phase angle or other quantitative difference of two currents or of some other electrical quantities.
▲88	<b>auxiliary motor or motor generator</b> is one used for operating auxiliary equipment such as pumps, blowers, exciters, rotating magnetic amplifiers, etc.
89	<b>line switch</b> is used as a disconnecting or isolating switch in an a-c or d-c power circuit, when this device is electrically operated or has electrical accessories, such as an auxiliary switch, magnetic lock, etc.
90	<b>regulating device</b> functions to regulate a quantity, or quantities, such as voltage, current, power, speed, frequency, temperature, and load, at a certain value or between certain limits for machines, tie lines or other apparatus.
91	<b>voltage directional relay</b> is a device which operates when the voltage across an open circuit breaker or contactor exceeds a given value in a given direction.
92	<b>voltage and power directional relay</b> is a device which permits or causes the connection of two circuits when the voltage difference between them exceeds a given value in a predetermined direction and causes these two circuits to be disconnected from each other when the power flowing between them exceeds a given value in the opposite direction.
93	<b>field changing contactor</b> functions to increase or decrease in one step the value of field excitation on a machine.

device number	definition and function
94	<b>tripping or trip-free relay</b> is a device which functions to trip a circuit breaker, contactor, or equipment, or to permit immediate tripping by other devices; or to prevent immediate reclosure of a circuit interrupter, in case it should open automatically even though its closing circuit is maintained closed.
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97	Used only for specific applications on individual installations where none of the assigned numbered functions from 1 to 94 is suitable.
98	
99	

**Note:** A similar series of numbers, starting with 201 instead of 1, shall be used for those device functions in a machine, feeder or other equipment when these are controlled directly from the supervisory system. Typical examples of such device functions are 201, 205, and 294.



## devices performing more than one function

If one device performs two relatively important functions in an equipment so that it is desirable to identify both of these functions, this may be done by using a double function number and name such as:

27-59 undervoltage and overvoltage relay.

## suffix numbers

If two or more devices with the same function number and suffix letter (if used) are present in the same equipment, they may be distinguished by numbered suffixes as for example, 52X-1, 52X-2 and 52X-3, when necessary.

## suffix letters

Suffix letters are used with device function numbers for various purposes. In order to prevent possible conflict, any suffix letter used singly, or any combination of letters, denotes only one word or meaning in an individual equipment. All other words should use the abbreviations as contained in American Standard Z32.13-1950, or latest revision thereof, or should use some other distinctive abbreviation, or be written out in full each time they are used. Furthermore, the meaning of each single suffix letter, or combination of letters, should be clearly designated in the legend on the drawings or publications applying to the equipment.

**note:** For purposes of clarification, these suffix letters have been classified in several groupings as listed in 2-9.4.1 to 2-9.4.5. The letters in 2-9.4.1 to 2-9.4.3, since they should generally form part of the device function designation, are written directly behind the device function number, as for example 23X, 90V or 52BT. The letters in 2-9.4.4, which denote parts of the main device, and those in 2-9.4.5 which cannot or need not form part of the device function designation, are written directly below the device function number, as for example  $\frac{20}{LS}$  or  $\frac{43}{A}$ .

These letters denote **separate auxiliary devices**, such as

- X } —auxiliary relay\*
- Y }
- Z }
- R —raising relay
- L —lowering relay
- O —opening relay
- C —closing relay
- CS —control switch
- CL —"a" auxiliary-switch relay
- OP —"b" auxiliary-switch relay
- U —"up" position-switch relay
- D —"down" position-switch relay
- PB —push button

\***note:** In the control of a circuit breaker with so-called X-Y relay control scheme, the X relay is the device whose main contacts are used to energize the closing coil and the contacts of the Y relay provide the anti-pump feature for the circuit breaker.

These letters indicate the **condition or electrical** quantity to which the device responds, or the medium in which it is located, such as:

- A —air, or amperes
- C —current
- E —electrolyte
- F —frequency, or flow
- L —level, or liquid
- P —power, or pressure
- PF —power factor

- Q —oil
- S —speed
- T —temperature
- V —voltage, volts, or vacuum
- VAR—reactive power
- W —water, or watts

These letters denote the **location of the main device in the circuit**, or the type of circuit in which the device is used or the type of circuit or apparatus with which it is associated, when this is necessary, such as:

- A —alarm or auxiliary power
- A-C —alternating current
- AN —anode
- B —battery, or blower, or bus
- BK —brake
- BP —bypass
- BT —bus tie
- C —capacitor, or condenser, compensator, or carrier current
- CA —cathode
- D-C —direct current
- E —exciter
- F —feeder, or field, or filament
- G —generator, or ground\*\*
- H —heater, or housing
- L —line
- M —motor, or metering
- N —network, or neutral\*\*
- P —pump
- R —reactor, or rectifier
- S —synchronizing
- T —transformer, or test, or thyatron
- TH —transformer (high-voltage side)
- TL —transformer (low-voltage side)
- TM —telemeter
- U —unit

\*\*Suffix "N" is generally used in preference to "G" for devices connected in the secondary neutral of current transformers, or in the secondary of a current transformer whose primary winding is located in the neutral of a machine or power transformer, except in the case of transmission line relaying, where the suffix "G" is more commonly used for those relays which operate on ground faults.

These letters denote **parts of the main device**, divided in the two following categories:

**all parts, except auxiliary contacts and limit switches** as covered later under 2-9.4.4.2, such as:

- BB —bucking bar (for high speed d-c circuit breaker)
- BK —brake
- C —coil, or condenser, or capacitor
- CC —closing coil
- HC —holding coil
- IS —inductive shunt
- L —lower operating coil
- M —operating motor
- MF —fly-ball motor
- ML —load-limit motor
- MS —speed adjusting, or synchronizing, motor
- S —solenoid
- TC —trip coil
- U —upper operating coil
- V —valve

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**All auxiliary contacts and limit switches** for such devices and equipment as circuit breakers, contactors, valves and rheostats. These are designated as follows:

- a —Auxiliary switch, open when the main device is in the de-energized or non-operated position.
- b —Auxiliary switch, closed when the main device is in the de-energized or non-operated position.
- aa—Auxiliary switch, open when the operating mechanism of the main device is in the de-energized or non-operated position.
- bb—Auxiliary switch, closed when the operating mechanism of the main device is in the de-energized or non-operated position.

e, f, h, etc., ab, ac, ad, etc., or ba, bc, bd, etc., are special auxiliary switches other than a, b, aa, and bb. Lower-case (small) letters are to be used for the above auxiliary switches.

**note:** If several similar auxiliary switches are present on the same device, they should be designated numerically 1, 2, 3, etc. when necessary.

LC—Latch-checking switch, closed when the circuit breaker-mechanism linkage is relatched after an opening operation of the circuit breaker.

LS—limit switch

These letters cover **all other distinguishing features or characteristics or conditions**, not specifically described in 2-9.4.1 to 2-9.4.4, which serve to describe the use of the device or its contacts in the equipment such as:

- A —accelerating, or automatic
- B —blocking, or backup
- C —close, or cold
- D —decelerating, detonate, or down
- E —emergency
- F —failure, or forward
- H —hot, or high
- HR —hand reset
- HS —high speed
- L —left, or local, or low, or lower, or leading
- M —manual
- OFF —off
- ON —on
- O —open
- P —polarizing
- R —right, or raise, or reclosing, or receiving, or remote, or reverse
- S —sending, or swing
- T —test, or trip, or trailing
- TDC—time-delay closing
- TDO—time-delay opening
- U —up

## representation of device contacts on electrical diagrams

**On electrical diagrams** all contacts should be shown in the de-energized or non-operated position of the main device.

**On relays, or other electromagnetically operated devices**, the contacts should be shown in the position they assume with all coils de-energized. In the case of relays or devices that operate in response to other than electrical quantities, the energizing influences for such devices are considered to be, respectively, as follows:

relay or device	energizing influence
temperature	rising temperature
level	rising level
flow	increasing flow
speed	rising speed
vibration	increasing vibration
pressure	increasing pressure
vacuum (see note)	increasing pressure

Hence, the contacts of these devices should be shown in the position that they assume when the quantities to which they respond are at their lowest value.

**note:** High vacuum is merely low pressure, and so the contacts of vacuum relays should be shown in the position they assume with a perfect vacuum.

**On circuit breakers and disconnecting switches**, the main and auxiliary contacts should be shown in the position they assume when these main circuit devices are in the open position. On valves, the auxiliary contacts should be shown with the valve in the closed position.

**On speed, voltage, current load or similar adjusting devices**, comprising rheostats, springs, levers or other components for the purpose, the auxiliary contacts should be shown in the position corresponding to the lowest adjustment of the above quantities.

**note:** When these adjusting devices are motor operated and are provided with limit switches for the motor circuit, the limit switches used for controlling the motor, and *only these*, should be shown in the position they assume when the device is in position between the extreme limits of travel.

**The opening or closing settings\* of the contacts or auxiliary switches** cited in 2-9.7.2 and 2-9.7.3 should, when necessary for the ready understanding of the operation of the devices in the equipment, be indicated on the elementary diagram for each such contact.

In the case of devices, which have no de-energized or non-operated position, such as manually operated transfer or control switches or auxiliary position indicating contacts on the housings or enclosures of a removable circuit breaker unit, the preferred method of showing the contacts of these devices is *normally open*. Each contact should, however, be identified on the elementary diagram as to when it closes\*. For example, the contacts of the Manual-Automatic Transfer Switch #43 which are closed in the *automatic* position would be identified with the letter "A", and those that are closed in the *manual* position would be identified with the letter "M"; and the auxiliary position switches on the housing 52H of a removable circuit breaker unit which are closed when the unit is in the connected position may be identified by the suffix letters "IN" and those which are closed when the unit is withdrawn from the housing may be identified by the suffix letters "OUT".

On special types of devices not described above, such as electrically operated latched-in relays or contactors or other devices which have no de-energized or non-operated position, their contacts should be shown in the position most suitable for the ready understanding of the operation of the devices in the equipment and sufficient description should be present, as necessary, on the elementary diagram to indicate the contact operation\*.

**\*note:** This information should be included on that part of the elementary diagram, either with the device symbol or with the contacts in the circuit diagram itself, where most convenient for the ready understanding of the operation of the devices and the equipment.



**proposed supplement AIEE no. 68**

**device numbers and functions**

**for pipeline pump stations under automatic or remote control**

**introduction**

This proposed AIEE Standard for trial use as a supplement to American Standard C37.2 has been formulated by a project group of the Transportation Subcommittee of the AIEE Committee on the Petroleum Industry, Industry Division, with the cooperation of the Automatic and Supervisory Control Subcommittee of the AIEE Committee on Substations.

Objective is the establishment of standards particularly suited to pipeline station control practice and supplemental to existing American Standard C37.2 for Automatic Station Control, Supervisory and Associated Telemetering Equipments.

Standard C37.2 originated in the Automatic and Supervisory Control Subcommittee of the AIEE Substation Committee, Power Division. Its content is broadly useful in the field of pipeline station control, since it covers the basic devices and functions of automatic and supervisory control systems. However, there are many functions specific to pipeline control practice that are naturally outside the scope of the existing standard. Standardization of these peculiarly pipeline functions and device designations offers important advantages to engineers in the pipeline field, where control systems are typically extensive and the use of automatic and supervisory control has grown rapidly in recent years.

The proposed supplementary standards for pipelines are based on the 1956 revision of American Standard C37.2. Adoption of this supplement as an American Standard would require further minor changes in C37.2, affecting sections 2-1, 2-9.2, 2-9.3, and 2-9.4.

The following comments are explanatory of the content of this proposed supplement:

- (a) Device Numbers 39 (Mechanical Condition Monitor) and 45 (Atmospheric Condition Monitor) are appropriated from the numbers reserved for future application in C37.2, to designate functions for which there are no provisions in the existing standards. The new device function 39 may logically be expanded in the future to include the present overspeed and underspeed device functions 12 and 14 of C37.2, which action is recommended to the Automatic and Supervisory Subcommittee.
- (b) Device Number 63 in C37.2 covers a Liquid or Gas Pressure, Level or Flow Relay. In pipeline practice these devices are used in such multiplicity that identification of all types and applications under a single device number involves extremely cumbersome suffixes. After consideration of this difficulty, the AIEE Automatic and Supervisory Control Subcommittee has agreed to the appropriation of two additional device function numbers presently unused. These numbers are applied as follows:
  - 63—Pressure switch
  - 71—Level switch
  - 80—Flow switch

This procedure eliminates the suffix letters P, L, and F previously required to accommodate the functions of pressure, level, and flow all under the single device number 63. Confusion is thereby avoided with certain suffixes for Device Function 88, where P is used for "Pump", L for "Lube", and F for "Fan".

- (c) Device Number 20, the valve, is an extremely important adjunct to pipeline operation. Valves occur in great numbers, varied locations and applications, and employ various means of actuation. Even when operated non-electrically they frequently incorporate auxiliary switches carrying electric circuits for position indication and interlocking in the electric system. It is often desirable to convey knowledge of these conditions in the device number. It is particularly useful to designate the operation of all activated auxiliary switch contacts. To accomplish these objectives a selection of suffixes is recommended for use with Device Number 20.

The proposed use of suffixes ac, ao, bc, bo, tc and to for valve operators is an extension of paragraph 2-9.4.4.2 of C37.2-1956, which provides for special auxiliary switch designations in addition to the standard a, b, aa, and bb auxiliary switches for circuit breakers. The employment of characters is such that the first letter indicates the condition of auxiliary switch contact corresponding to the position of valve as indicated by the second letter. The following considerations will further clarify the nomenclature employed:

Letters c and o represent respectively the fully-open and fully-closed position of the valve. A percentage figure in lieu of c or o indicates a zone of valve traverse, in percent of full travel, measured from the fully-closed position. A closed valve corresponds to an open breaker (non-operative) and an open valve corresponds to a closed breaker (operative). In the case of a breaker being closed, ordinarily the exact point at which an "a" auxiliary switch closes or a "b" switch opens is not critical. But in the case of a valve being opened it may be necessary to perform separate opening or closing operations of auxiliary switch contacts (1) when the valve leaves the closed position and (2) when the valve reaches the open position. Thus the terminology used with circuit breakers does not suffice for valves, and extensions of the "a" and "b" switch concepts are employed, wherein:

- ac —An "a" switch operative at the "closed" valve position. Switch is open in closed valve position, closes when valve leaves closed position, reopens when valve returns to closed position. Switch is open only when valve is fully closed.
- ao —An "a" switch operative at the "open" valve position. Switch is open in closed valve position, closes when valve reaches open position, reopens when valve leaves open position. Switch is open except when valve is fully open.



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- bc —A "b" switch operative at the "closed" valve position. Switch is closed in closed valve position, opens when valve leaves closed position, recloses when valve returns to the closed position. Switch is closed only when valve is fully closed.
- bo —A "b" switch operative at the "open" valve position. Switch is closed in closed valve position, opens when valve reaches open position, recloses when valve leaves open position. Switch is closed except when valve is fully open.
- a10%—An "a" switch operative at the "10% open" valve position. Switch is open in closed valve position, closes when valve reaches 10% open position, re-opens when valve returns to 10% open position. Switch is open except when valve is 10% or more, open.
- b10%—A "b" switch operative at the "10% open" valve position. Switch is closed in closed valve position, opens when valve reaches 10% open position, recloses when valve returns to 10% open position. Switch is closed except when valve is 10%, or more, open.

This nomenclature is further clarified by an operation chart incorporated in the Proposed Standard.

It will be observed that the first letter indicates type of auxiliary switch by position of contact when valve is non-operative, while the second character indicates the position of the valve at which the auxiliary switch operates.

- (d) Device Number 88, auxiliary motor. Due to the variety of auxiliary drives employed in pipeline service, specific application designations are provided by using as a first suffix, F for Fan, P for Pump, C for Compressor; and, where desirable, second suffix letters consistent with usages established for Devices 63, 71 and 80.
- (e) Standard C37.2, paragraph 2-9.3 now provides that a series of numbers starting with 201 instead of 1, shall be used for device functions controlled directly from the supervisory system. (Examples 201, 205, 294.) This supplement recommends instead, that the letters SC be used as a prefix to indicate device functions controlled directly from the supervisory system, typical examples being SC1, SC2, SC94.

This modification releases all numbers above 100, thereby permitting this supplement to accommodate a practice having wide prior use in multi-unit pipeline stations, whereby numbers from 1 to 99 are employed for designation of functions which concern the station as a whole, while the functions of unit no. 1 are designated by numbers from 101 to 199, unit no. 2 by 201 to 299 and so on for as many units as are involved.

For example, an a-c Time Overcurrent Relay for the main station breaker is designated 51, while a corresponding relay for Pump Unit no. 1 is 151; for Pump Unit no. 2 it is 251, etc.

This practice is advantageous where a single diagram shows devices pertaining to station operation as well as other devices of the same function pertaining individually to several units, and where provision must be made for interlocking and sequence control involving more than one unit.



## proposed device numbers and functions

(For trial use as supplement of American Standard C37.2)

### 2-OP references

In this proposed standard, numerical references to sections and paragraphs apply to American Standard C37.2—1956, except those containing suffix letter P, which apply to this proposed standard.

The marginal designation (new) indicates content not now included in C37.2, while (rev.) indicates proposed modifications thereof.

### 2-1P scope

(rev.) This standard applies to the performance and application of devices when used for the automatic, partial automatic, and supervisory control and associated telemetering and supervisory indication in connection with electric power substations and generating stations. As set forth in this supplement, the standard applies also to pump stations on petroleum and natural gas pipelines.

**note:** The device function numbers in Section 2-9 may apply to manual, as well as to partial automatic and automatic control equipments.

**2-9.2P (new)** **standard device function numbers** for pipeline control practice shall be those designated in 2-9.2 with the following exceptions:

**20 (rev.)** **electrically operated valve** is a valve, used in a fluid line, which is electrically operated, controlled or indicated.

**note:** The function of the valve may be indicated by the insertion of descriptive words, such as "Brake" or "Pressure Reducing" in the function name, such as "Electrically-operated Brake Valve." In the case of pipelines the function of the valve may be indicated by suffix as provided in section 2-9.4.6P (2).

**39 (new)** **mechanical condition monitor** is a device which functions upon the occurrence of an abnormal mechanical condition, such as vibration, or seal failure (not including bearing temperature which is covered by Device Function Number 38).

**45 (new)** **atmospheric condition monitor** is a device which functions upon the occurrence of a predetermined atmospheric condition, such as hazardous explosive atmosphere, smoke, or fire.

**63 (rev.)** **pressure switch** is a switch which operates on given values, or on a given rate of change, of pressure.

**71 (new)** **level switch** is a switch which operates on given values, or on a given rate of change, of level.

**80 (new)** **flow switch** is a switch which operates on given values, or on a given rate of change, of flow.

**2-9.3P (rev.)** In pipeline control practice a similar set of numbers preceded by the letters SC shall be used for those device functions in a machine, feeder, or other equip-

ment when these are controlled directly from the supervisory system. Typical examples of such device functions are SC1, SC5, and SC94; also SC101 and SC105 as provided in section 2-9.3.1P.

**2-9.3.1P** In pipeline pump stations, the numbers 1 through 99 shall apply to device functions which concern the overall station operation. A similar series of numbers, starting with 101 instead of 1, shall be used for those device functions which concern unit 1; a similar series starting with 201 for device functions which concern unit 2; and so on for each unit. Any other desired identification should be added only as a parenthetical suffix to the device function number.

**2-9.4.6P (new)** In pipeline control practice, certain device functions may be extended by suffixes as shown below. These suffixes apply only to the device numbers under which they are listed, except suffixes listed for Device Number 88 may be used also with other device numbers.

#### (1) device function 8: control (or auxiliary) power disconnecting device.

When used for non-essential auxiliary power circuits the following designation may be applied:

8NE—auxiliary power disconnecting device for non-essential load.

#### (2) device function 20: valve

(a) The following suffix letters may be used to designate application:

BD—Blowdown	MA—Manifold
BL—Block	PR—Pressurizing
BP—Bypass	RC—Recycling
CH—Check	RF—Relief
D—Discharge	S—Suction
EP—Electro-pneumatic instrumentation	TT—Throttling control
IS—Isolation	VT—Vent

(b) The following suffixes may be used to indicate the operation of mechanically-actuated auxiliary switches on valves. These shall be lower-case (small) letters in accordance with 2-9.4.4.2 and ordinarily shall be written directly below the device number as provided in 2-9.4.

ac—open only when valve is fully closed  
ao—open except when valve is fully open  
bc—closed only when valve is fully closed  
bo—closed except when valve is fully open  
tc—opened by torque-responsive mechanism, to stop valve closing  
to—opened by torque-responsive mechanism, to stop valve opening

Letter a (or b) may be followed by a numerical suffix to designate that the contacts are open

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(or closed) through the indicated percentage traverse of the valve from its closed position.

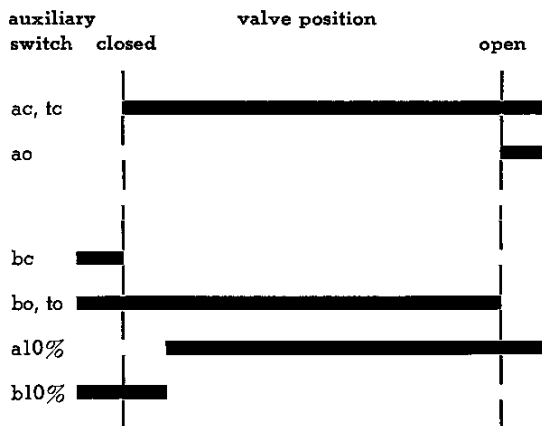
## examples:

**20BL** designates, on a block valve, an auxiliary switch, open only when the valve is fully closed.

**20S** designates, on a suction valve, an auxiliary switch, torque-opened to stop the valve closing.

**20D** designates, on a discharge valve, an auxiliary switch, open except when the valve is 10%, or more, open.

**note 1:** On diagrams containing the foregoing auxiliary switch designations, operation should be charted as follows:



**note 2:** The designations of auxiliary switches on solenoid valves are as set forth in 2-9.4.4.2. The word "solenoid" shall be inserted ahead of the word "valves" in the third line of that paragraph.

**note 3:** In conformity with 2-9.4.1, suffixes O and C (capital letters) shall be used to designate the opening and closing contactors controlling motorized valve operators. Thus 20BLO is the opening contactor of a block valve.

**note 4:** In a system involving a number of valves, the individual valves may be designated by suffix numbers, as provided in 2-9.5, thus: 20-1, 20-2, 20-3, etc. For each such valve the application should be shown in a device number table and the location in the piping system should be shown in an elementary piping diagram.

- (3) **device function 26: apparatus thermal device**  
The apparatus to which the thermal device is applied may be identified as follows:

26PC—pump case over-temperature device.

- (4) **device function 33: position switch**

To indicate a Line Scraper Passage Signal Device this designation may be supplemented as follows:

33SS —Scraper Passage Signal Device  
33SA—Arriving Scraper Signal Device  
33SD —Departing Scraper Signal Device  
33SR —Received Scraper Signal Device

- (5) **device function 38: bearing protective device**

The protected bearing may be identified as follows:

38M1—Motor bearing, inboard  
38M2—Motor bearing, outboard  
38P1 —Pump bearing, inboard  
38P2 —Pump bearing, outboard  
38C1 —Compressor bearing, inboard  
38C2 —Compressor bearing, outboard  
38L1 —Gear bearing, low speed, inboard  
38L2 —Gear bearing, low speed, outboard  
38H1 —Gear bearing, high speed, inboard  
38H2 —Gear bearing, high speed, outboard

**note:** Where more than two bearings are employed in the same axial line, they are numbered consecutively from the inboard, or drive, end.

- (6) **device function 39: mechanical condition monitor**

Specific types are designated by suffix as follows:

39VB—Vibration monitor  
39SF —Seal failure monitor

- (7) **device function 45: atmosphere condition monitor**

Specific types are designated by suffix as follows:

45HA—Explosive atmosphere monitor  
45SM—Smoke monitor  
45FR —Fire monitor

- (8) **device function 63: pressure switch**

The following designations may be used for specific applications:

63S —Switch responsive to suction pressure  
63D —Switch responsive to discharge pressure  
63PC—Switch responsive to pump case pressure  
63PT —Switch responsive to pressure on pump side of station control valve  
63J —Switch responsive to differential pressure  
63JP —Switch responsive to pump differential pressure  
63JTT—Switch responsive to differential pressure across station control valve  
63JST—Switch responsive to differential pressure across strainer  
63JFI—Switch responsive to differential pressure across filter



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**device function 63: pressure switch—cont'd**

- 63JR —Switch responsive to differential air pressure between two rooms
- 63AR —Switch responsive to pressure of room ventilation air
- 63AM —Switch responsive to pressure of air delivered to force-ventilated motor
- 63LO —Switch responsive to pressure of lubricating oil
- 63SO —Switch responsive to pressure of seal oil
- 63W —Switch responsive to pressure of water
- 63AI —Switch responsive to pressure of instrument air

**(9) device function 71: level switch**

- 71SB —Switch responsive to level in scrubber<sup>71</sup>
- 71SO —Switch responsive to level in seal oil tank
- 71ST —Switch responsive to level in stock or storage tank
- 71SU —Switch responsive to level in station sump

**(10) device function 80: flow switch**

- 80AR —Switch responsive to flow of room ventilation air
- 80AM —Switch responsive to flow of air to force ventilated motor
- 80LO —Switch responsive to flow of lubricating oil
- 80SO —Switch responsive to flow of seal oil
- 80W —Switch responsive to flow of water

**(11) device function 88: auxiliary motor**

The following designations may be used for specific applications:

- 88F —Fan
- 88FR —Fan delivering air to room for ventilation thereof
- 88FE —Fan exhausting air from room
- 88FSH —Fan on space heating unit
- 88FSC —Fan on space cooling unit
- 88FM —Fan serving forced ventilated motor
- 88FC —Fan serving forced air cooler
- 88P —Pump
- 88PSU —Pump, sump
- 88PLO —Pump, lube oil
- 88PSO —Pump, seal oil
- 88PW —Pump, water
- 88C —Compressor
- 88CAI —Compressor, instrument air
- 88LL —Lubricator

**note:** The above designations indicate the motor of the auxiliary equipment. Other elements are indicated by substituting the appropriate device function number; thus, 42F designates a running circuit breaker (or contactor for a fan).