Important Safety and Product Information

About Safety Guidelines and Warranties/Terms and Conditions of Sale

Important User Information

This guide has been developed as a quick reference tool to Allen-Bradley industrial automation controls and factory assemblies. It is not intended to replace factory user manuals or technical documentation supplied with Allen-Bradley equipment.

Because of the variety of uses for the products described in this publication, those responsible for the application and use of these products must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes, and standards. Factory provided user manuals and technical documentation should not be solely relied on for those purposes. Rockwell Automation reserves the right to change the features or characteristics of its products at any time. Therefore, the information contained in this publication is subject to change at any time without notice.

The illustrations, charts, diagrams, and layout examples shown in this guide are intended solely as examples. Since there are many variables and requirements associated with any particular installation, Rockwell Automation can not assume responsibility or liability (including intellectual property infringement liability) for actual use based upon the examples shown in this publication.

Allen-Bradley Publication SGI-1.1 “General Information Safety Guidelines for Solid-State Control” (available from you local Rockwell Automation office) describes some important differences between solid-state equipment and electromechanical devices, which should be taken into consideration when applying products such as those described in this publication.

Conformal Coating Offering

Rockwell Automation offers a conformal coating solution on selected Allen-Bradley products to satisfy customers who demand that their automation equipment have additional protection against corrosive elements, such as sulfuric acid, chlorine, fungus, salt, and other chemicals and gases.

Rockwell Automation reviews conformal coating opportunities on an individual basis and provides customer pricing. To receive a quote, please contact your local Rockwell Automation Sales Office.

Service and Installation Conditions

Unless otherwise noted, the products described in this publication are designed to meet “usual service and installation conditions” as defined in NEMA (National Electrical Manufacturers Association) Standards Publication - Part ICS 1-108. Open-style devices must be provided with environmental and safety protection by proper mounting in enclosures designed for specific application conditions. See NEMA Standards Publication 250 and IEC Publication 529, as applicable, for explanations of the degrees of protection provided by different types of enclosures.

Performance Data

Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.

GENERAL TERMS AND CONDITIONS OF SALE

These general terms and conditions of sale only apply to purchases of Allen-Bradley and Rockwell Software branded products and related services made directly from Rockwell Automation. Purchases made from appointed distributors or other independent resellers will be subject to terms and conditions of sale as may be separately established by each such distributor or reseller, which will in no event be binding upon Rockwell Automation unless otherwise expressly agreed to. Sales outside of North America, as well as sales of other Rockwell Automation products and services, may be subject to separate or supplemental terms and conditions of sale. For further information, please consult your nearest Rockwell Automation sales office.

General

These general terms and conditions of sale (along with any associated written specification, quotation and/or supplemental terms and conditions provided by Seller) exclusively will govern the sale or licensing by Seller of all goods and services (including without limitation, hardware, firmware and software products, training, programming, maintenance, engineering, parts, repair and remanufacturing services – hereinafter, “Products”) furnished to Buyer hereunder, whether such sale or licensing is effected by paper-based transactions or via facsimile or other forms of electronic data interchange (“EDI”) or electronic commerce, and represents the entire agreement between Buyer and Seller with respect thereto. Buyer’s receipt or acceptance of delivery of any of the Products ordered or purchased hereunder will constitute its acceptance of these terms and conditions. No addition or modification to these terms and conditions will be binding on Seller unless agreed to in writing signed by an authorized representative at Seller’s headquarters. Seller objects to and rejects other terms and conditions that may be proposed by Buyer or that appear on or are referenced in Buyer’s purchase order or requisition that are in addition to or otherwise not consistent with the terms and conditions set forth or referenced herein.

Payment Terms

Net thirty (30) days from date of invoice with ongoing approved credit as determined by Seller. Seller may render partial invoices and require progressive payments. Seller reserves the right to render invoices electronically and to receive payment by way of electronic funds transfer. Payment by credit card, when permitted, is subject to credit card validation and authorization both at time of agreement and immediately prior to shipment. Seller reserves the right to suspend any further performance hereunder or otherwise in the event payment is not made when due. No payment by offset is permitted. Interest charges will be added to overdue invoices at the rate of 1.5% per month (subject to any limit imposed by applicable law).

Delivery Terms

Delivery terms are Ex Works Seller’s plant or warehouse (per current Incoterms) or as otherwise agreed to as evidenced by Seller’s order acknowledgment. In all cases title transfers to Buyer upon the earlier of Seller’s delivery to Buyer or receipt by the first carrier for transport to Buyer, except that title to all intellectual property rights associated with the Products remains with Seller or its suppliers and licensors. Acknowledged shipping dates are approximate only and based on prompt receipt of all necessary information from Buyer. Seller disclaims all liability for late delivery. Where applicable, prepaid shipping will be billed as a separate invoice item.

Warranty

(a) Hardware: Seller warrants that new hardware Products furnished hereunder will be free from defects in material, workmanship and design for a period of one (1) year from the date of invoice from Seller or its appointed distributor, as the case may be. Repaired or replacement Products provided as a result of this warranty subparagraph are similarly warranted for a period of six (6) months from the date of shipment to Buyer or the remainder of the original warranty term for that particular Product, whichever is longer.

(b) Software and Firmware: Unless otherwise provided in a Seller or third party license, Seller warrants that standard software or firmware Products furnished hereunder, when used with Seller-specified hardware, will perform in accordance with published specifications prepared, approved, and issued by Seller for a period of one (1) year from the date of invoice from Seller or its appointed distributor, as the case may be. Seller makes no representation or warranty, express or implied, that the operation of the software or firmware Products will be uninterrupted or error free, or that the functions contained therein will meet or satisfy Buyer’s intended use or requirements.

(c) Non-Warranty Factory Remanufacture, Repair and Field Exchange: Seller warrants that non-warranty factory remanufactured or field exchanged hardware Products or repaired hardware Product

components will be free from defects in material and workmanship for a period of one (1) year from the date of invoice from Seller or its appointed distributor, as the case may be. Repaired or replacement Products provided as a result of this warranty subparagraph are warranted for a period of thirty (30) days from the date of shipment to Buyer or the remainder of the original warranty term, whichever is longer.
(d) Services: Seller warrants that Products comprised solely of services (e.g., training, on-site repair, engineering and custom application programming services) will be performed by appropriately skilled personnel employed or retained by Seller.
(e) "Open Box" Products: Seller warrants that hardware Products sold as "Open Box" (e.g., customer and distributor returns, factory refurbished or reconditioned, etc.) will be free from defects in material and workmanship for a period of ninety (90) days from the date of invoice from Seller or its appointed distributor, as the case may be. "Open Box" Products, while serviceable, may not reflect the latest series or revision. Repaired or replacement Products provided as a result of this warranty subparagraph are similarly warranted for a period of thirty (30) days from the date of shipment to Buyer or the remainder of the original ninety-day warranty term for that particular Product, whichever is longer.
(f) Buyer Specifications/Compatibility: Seller does not warrant and will not be liable for any design, materials, construction criteria or goods furnished or specified by Buyer (including that sourced from other manufacturers or vendors specified by Buyer). Any warranty applicable to such Buyer-specified items will be limited solely to the warranty, if any, extended by the original manufacturer or vendor directly or indirectly to Buyer. Seller does not warrant the compatibility of its Products with the goods of other manufacturers or Buyer's application except to the extent expressly represented in Seller's published specifications or written quotation.
(g) Recyclable Materials: In keeping with environmental policies and practices, Seller reserves the right to utilize in its product manufacturing, repair and remanufacturing processes certain recyclable materials (e.g., fasteners, plastics and the like) or remanufactured parts equivalent to new in performance or parts which may have been subject to incidental use. However, such utilization will not affect any provided Product warranty or published reliability statistics.
(h) Remedies: Remedies under the above warranties will be limited, at Seller's option, to the replacement, repair, re-performance or modification of, or issuance of a credit for the purchase price, of the Products involved, and where applicable, only after the return of such Products pursuant to Seller's instructions. Replacement Products may be new, remanufactured, refurbished or reconditioned at Seller's discretion. Buyer requested on-site warranty service (consisting of time, travel and expenses related to such services) will be at Buyer's expense. The foregoing will be the exclusive remedies for any breach of warranty or breach of contract arising therefrom.
(i) General: Warranty satisfaction is available only if (a) Seller is provided prompt written notice of the warranty claim and (b) Seller's examination discloses that any alleged defect has not been caused by misuse; neglect; improper installation, operation, maintenance, repair, alteration or modification by other than Seller; accident; or unusual deterioration or degradation of the Products or parts thereof due to physical environment or electrical or electromagnetic noise environment.
(j) THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES AND CONDITIONS, WHETHER EXPRESSED, IMPLIED OR STATUTORY, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE, OR PERFORMANCE OR APPLICATION WARRANTIES, TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW. Rights under the above warranties (subject to noted limitations) extend to Buyer's customers if Buyer is a Seller-appointed distributor for the Products.

Disclaimer and Limitation of Liability

TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, SELLER WILL NOT BE LIABLE FOR ANY BUSINESS INTERRUPTION OR LOSS OF PROFIT, REVENUE, MATERIALS, ANTICIPATED SAVINGS, DATA, CONTRACT, GOODWILL OR THE LIKE (WHETHER DIRECT OR INDIRECT IN NATURE) OR FOR ANY OTHER FORM OF INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND. SELLER'S MAXIMUM CUMULATIVE LIABILITY RELATIVE TO ALL OTHER CLAIMS AND LIABILITIES, INCLUDING OBLIGATIONS UNDER ANY INDEMNITY, WHETHER OR NOT INSURED, WILL NOT EXCEED THE COST OF THE PRODUCT(S) GIVING RISE TO THE CLAIM OR LIABILITY. SELLER DISCLAIMS ALL LIABILITY RELATIVE TO GRATUITOUS INFORMATION OR ASSISTANCE PROVIDED BY, BUT NOT REQUIRED OF SELLER HEREUNDER. ANY ACTION AGAINST SELLER MUST BE BROUGHT WITHIN EIGHTEEN (18) MONTHS AFTER THE CAUSE OF ACTION ACCRUES. THESE DISCLAIMERS AND LIMITATIONS OF LIABILITY WILL APPLY REGARDLESS OF ANY OTHER CONTRARY PROVISION HEREOF AND REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE AND STRICT LIABILITY) OR OTHERWISE, AND FURTHER WILL EXTEND TO THE BENEFIT OF SELLER'S VENDORS, APPOINTED DISTRIBUTORS AND OTHER AUTHORIZED RESELLERS AS THIRD-PARTY BENEFICIARIES. EACH PROVISION HEREOF WHICH PROVIDES FOR A LIMITATION OF LIABILITY, DISCLAIMER OF WARRANTY OR CONDITION OR EXCLUSION OF DAMAGES IS SEVERABLE AND INDEPENDENT OF ANY OTHER PROVISION AND IS TO BE ENFORCED AS SUCH.

Intellectual Property Indemnity

Except as excluded herein, Seller will defend any suit or proceeding brought against Buyer arising out of a claim that the design or construction of the Products sold or licensed hereunder by Seller infringes any patent, copyright or trademark granted or registered in the country of Seller's shipping destination, provided (a) Buyer promptly notifies Seller in writing of any such claim and any suit or proceeding, (b) at Seller's expense, Buyer gives Seller the sole right to defend, settle and control the defense of the suit or proceeding, (c) Buyer provides all necessary information and assistance for such defense or settlement, and (d) Buyer takes no position adverse to Seller in connection with such claim. In the event Seller is obligated to defend such suit or proceeding, Seller will pay all costs and damages finally awarded or agreed upon by Seller that are directly related thereto. Seller's obligations under this paragraph will be fulfilled if Seller, at its option and expense: (i) procures for Buyer the right to continue using such Products, (ii) replaces the same with non-infringing equipment/software having functionality similar to that of the Products, (iii) modifies the Products to make them non-infringing while retaining similar functionality, or (iv) if (i)-(iii) are not commercially practicable, refunds to Buyer the purchase price of the affected Products in exchange for their return. Seller will have no obligation to defend or for any other liability with respect to: [a] any suit or proceeding to the extent based on or arising out of a configuration or modification made, specified or requested by Buyer and which is incorporated into or constitutes the Products, [b] the use of the Products in a process or application specified, requested or controlled by Buyer or any third parties, or [c] the use of the Products in combination with other equipment, software or materials not supplied by Seller. As used in this paragraph, the term "Products" shall mean only Seller's standard hardware and software that are generally commercially available, and expressly excludes third-party-branded equipment/software. THIS PARAGRAPH IS IN LIEU OF ALL WARRANTIES OR REPRESENTATIONS, WHETHER EXPRESS OR IMPLIED, THAT THE PRODUCTS WILL BE FREE OF THE RIGHTFUL CLAIM OF ANY THIRD PARTY BY WAY OF INFRINGEMENT OR THE LIKE.

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Use of Products comprised of software or firmware may be subject to Buyer's acceptance of additional terms and conditions set forth in separate Seller or third-party license agreements that will control to the extent necessary to resolve any conflict with the terms and conditions stated or otherwise referenced herein. In the absence of a separate Seller's license agreement, Buyer is granted a non-exclusive, non-transferable license to use provided Seller's software or firmware only in object code form and solely in conjunction with Seller-provided Products, with no rights to sublicense, disclose, disassemble, decompile, reverse engineer, or otherwise modify the software or firmware.

Packing and Marking

Buyer-specified packing or marking may be subject to additional charges not otherwise included in the price of the Products.

Terms and Conditions of Sale

Weights and Dimensions

Published or advertised weights and dimensions are estimates or approximations only and are not warranted.

Prices

Prices and other information shown in any Seller publication (including product catalogs and brochures) are subject to change without notice and to confirmation by specific quotation. Such publications are not offers to sell and are maintained only as a source of general information. Prices do not include sales, use, excise, customs, value-added or similar taxes. Buyer will pay or reimburse Seller for all such taxes as may be applicable. Time and material services will be provided in accordance with Seller's published service rates (including applicable overtime and travel expenses) in effect as of the date such services are provided, unless otherwise confirmed by Seller's written quotation or order acknowledgment. Billable service time includes travel time to and from the job site and all time Seller's representatives are available for work and waiting (whether on or off the job site) to perform the services.

Changes and Substitutions

Buyer-requested order changes, including those affecting the identity, scope and delivery of the Products, must be documented in writing and are subject to Seller's prior approval and adjustments in price, scheduling and other affected terms and conditions. In any event, Seller reserves the right to reject any change that it deems unsafe, technically inadvisable or inconsistent with established engineering or quality guidelines and standards, or incompatible with Seller's design or manufacturing capabilities. Seller further reserves the right to substitute using the latest superseding revision or series or equivalent Product having comparable form, fit and function.

Returns

All returns of Products will be pursuant to Seller's instructions. Non-warranty returns of unused and resalable Products for credit will be subject to Seller's return policies in effect at the time, including applicable restocking charges and other conditions of return. Products returned under warranty must be properly packed and shipped to Seller-specified locations. Shipping containers must be clearly marked per Seller's instruction and shipped freight prepaid by Buyer. Notwithstanding the foregoing, all sales of "Open Box" Products and any third-party branded products are final and do not qualify for non-warranty return.

Order Cancellation

Cancellation by Buyer prior to shipment is permitted only by written notice and upon payment to Seller of reasonable cancellation and restocking charges, including reimbursement for direct costs. Cancellation charges associated with orders for custom Products or Products specifically manufactured to Buyer's specification may equal the actual selling price of the Products. Seller has the right to cancel an order for cause at any time by written notice, and Seller will be entitled to cancellation and restocking charges as identified above. No termination by Buyer for cause will be effective unless and until Seller has failed to correct such alleged cause within forty five (45) days after receipt of Buyer's written notice specifying such cause.

Force Majeure

Seller will not be liable for any loss, damage or delay arising out of its failure (or that of its subcontractors) to perform hereunder due to causes beyond its reasonable control, including without limitation, acts of God, acts or omissions of Buyer, acts of civil or military authority, fires, strikes, floods, epidemics, quarantine restrictions, war, riots, acts of terrorism, delays in transportation, or transportation embargoes. In the event of such delay, Seller's performance date(s) will be extended for such length of time as may be reasonably necessary to compensate for the delay.

Government Clauses and Contracts

Application of government contract regulations and clauses to the Products or the agreement evidenced by these terms and conditions are subject to the separate review and consent by an authorized representative at Seller's headquarters. Products sold or licensed hereunder are not intended to be used, nor should they be used, in any nuclear-related application either as a "Basic Component" as defined under United States nuclear regulations or under similar nuclear laws and regulations of any other country or otherwise.

Export Control

Products and associated materials supplied or licensed hereunder may be subject to various export laws and regulations. It is the responsibility of the exporter to comply with all such laws and regulations. Notwithstanding any other provision herein to the contrary, in the event that U.S. or local law requires export authorization for the export or re-export of any Product or associated technology, no delivery can be made until such export authorization is obtained, regardless of any otherwise promised delivery date. In the event that any required export authorization is denied, Seller will be relieved of any further obligation relative to the sale and/or license and delivery of the Product(s) subject to such denial without liability of any kind relative to Buyer or any other party. Seller will not comply with boycott related requests except to the extent permitted by U.S. law and then only at Seller's discretion.

Disputes

The parties will attempt in good faith promptly to resolve any dispute arising hereunder by negotiations between representatives of the parties who have authority to settle the dispute. If unsuccessful, the parties further will attempt in good faith to settle the dispute by non-binding third-party mediation, with mediator fees and expenses apportioned equally to each side. Any dispute not so resolved by negotiation or mediation may then be submitted to a court of competent jurisdiction in accordance with the terms hereof. These procedures are the exclusive procedures for the resolution of all such disputes between the parties.

Governing Law and Forum

The agreement evidenced hereby and all disputes arising thereunder will be governed by and interpreted in accordance with the internal laws and will be subject to the exclusive jurisdiction of the courts of the state, province or other governmental jurisdiction in which Seller's principal place of business resides, but specifically excluding the provisions of the 1980 UN Convention on Contracts for the International Sales of Goods. Should any term or provision hereof be held wholly or partly invalid or unenforceable under applicable law, the remainder of the agreement evidenced hereby will not be affected thereby.

Assignment

The agreement evidenced hereby may not be assigned by either party without the written consent of the other (which consent will not be unreasonably withheld). However, consent will not be required for internal transfers and assignments as between Seller and its parent company, subsidiaries or affiliates as part of a consolidation, merger or any other form of corporate reorganization.

Language

The parties acknowledge that they have required that the agreement evidenced hereby be drawn up in English. Les parties reconnaissent avoir exigé la rédaction en anglais du Contrat. In the event of a conflict between the English and other language versions, the English version will prevail.

Maintenance of Solid-State Control

This section is excerpted from Allen-Bradley publication SGI-1.1, Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control. It is formatted so that explanatory comments from Rockwell Automation appear in blue headings along with the corresponding parts of Section 5 of NEMA Standards Publication No. ICS 1.1-1987, titled Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control. The text from the NEMA Standard has been reprinted verbatim with NEMA's permission captioned "NEMA Standard Text". "Explanatory Information", contains the Rockwell Automation comments. The comments provide information to help readers better understand the characteristics of industrial equipment employing solid state technology. NEMA text is provided solely as a convenience to the reader, and Rockwell Automation assumes no responsibility for its completeness or validity.
NEMA Standards Publication No. ICS 1.1-1984, Rev. No. 1 - October 1987, is available from the National Electrical Manufacturers Association, 2101 L Street, N.W., Washington, DC 20037. Allen-Bradley Publication SGI-1.1 is available from your local Rockwell Automation office.

NEMA Standard Text
Section 5 Preventive Maintenance and Repair Guidelines

5.1 General

A well-planned and executed maintenance program is essential to the satisfactory operation of solid-state electrical equipment. The kind and frequency of the maintenance operation will vary with the kind and complexity of the equipment as well as with the nature of the operating conditions. Maintenance recommendations of the manufacturer or appropriate product standards should be followed.
Useful reference publications for setting up a maintenance program are NFPA 70B-1983, Maintenance of Electrical Equipment, and NFPA 70E-1983, Electrical Safety Requirements for Employee Workplaces.

5.2 Preventive Maintenance

The following factors should be considered when formulating a maintenance program:
1. Maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the control.
2. Maintenance should be performed with the control out of operation and disconnected from all sources of power. If maintenance must be performed while the control is energized, the safety related practices of NFPA 70E should be followed.
3. Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.
4. Ventilation passages should be kept open. If the equipment depends upon auxiliary cooling, e.g., air, water, or oil, periodic inspection (with filter replacement when necessary) should be made of these systems.
5. The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity (see 4.5).
6. Accumulations of dust and dirt on all parts, including on semiconductor heat sinks, should be removed according to the manufacturer's instructions, if provided; otherwise, the manufacturer should be consulted. Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris in a way that permits it to enter or settle into parts of the control equipment.
7. Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.
8. Certain hazardous materials removed as part of maintenance or repair procedure (e.g., polychlorinated biphenyls (PCB) found in some liquid filled capacitors) must be disposed of as described in Federal regulations.

C.5.2 Preventive Maintenance [Explanatory Information (Supplementary Comments - Not part of NEMA Standards Publication No. ICS 1.1)]

Lithium batteries are frequently used for memory backup in solid state equipment due to their excellent shelf life and high energy-to-weight ratio. Lithium is a highly reactive metal that can cause burns if there is contact with skin. The batteries are sealed so there is seldom a problem of contact with lithium as long as reasonable care is exercised when handling them. They should only be used in their intended application and not subjected to rough handling. When batteries are replaced in equipment, the batteries removed should be disposed of in accordance with the battery supplier's instructions.
The Department of Transportation has certain regulations that prohibit shipment of equipment with batteries installed if the batteries contain 0.5 grams or greater of lithium. The batteries must be removed from equipment and shipped separately in a container approved by the Department of Transportation. Additional Department of Transportation restrictions apply to the shipment of lithium batteries.
NEMA Standards Publication No. ICS 1.3-1986, Preventive Maintenance of Industrial Control and System Equipment, is recommended for personnel responsible for maintenance of equipment.

5.3 Repair

If equipment condition indicates repair or replacement, the manufacturer's instruction manual should be followed carefully. Diagnostic information within such a manual should be used to identify the probable source of the problem, and to formulate a repair plan. The level of field repair recommended by the manufacturer should be followed.
When solid state equipment is repaired, it is important that any replacement part be in accordance with the recommendations of the equipment manufacturer. Care should be taken to avoid the use of parts which are no longer compatible with other changes in the equipment. Also, replacement parts should be inspected for deterioration due to "shelf life" and for signs of rework or wear, which may involve factors critical to safety.
After repair, proper start-up procedures should be followed. Special precautions should be taken to protect personnel from hazards during start-up.

C.5.3 Repair [Explanatory Information (Supplementary Comments - Not part of NEMA Standards Publication No. ICS 1.1)]

Follow manufacturer's instructions exactly when replacing power semiconductors mounted on heatsinks since improper installation may become the source of further difficulties. Torque semiconductors or bolts retaining semiconductors to the value specified with a torque wrench. Too much pressure against a heatsink can damage a semiconductor, while too little can restrict the amount of heat transferred from the semiconductor to the heatsink, resulting in operation at higher temperature with decreased reliability.
Exercise care when removing modules from a system during maintenance. Failed modules are frequently returned to the manufacturer for repair. Any physical damage sustained during removal may result in more expensive repair or render the module unrepairable if damage is too great.
Modules with electrostatic sensitive components should be handled by the edges without touching components or printed circuit conductors. Use packaging material supplied with the replacement module when shipping the module to the manufacturer for repair.
When the scope of repairs exceeds the manufacturer's recommendations for field repair, the module(s) should be returned to the manufacturer for repair. Doing so will help to ensure that only properly selected components are used and that all necessary hardware and firmware revisions are incorporated into the repair. Failure to make necessary updates may result in safety, compatibility, or performance problems, which may not become apparent for some time after the repaired module has been placed back in service. When firmware is protected by copyright law, updates can be provided legally only by the manufacturer or licensee.

5.4 Safety Recommendations for Maintenance Personnel

All maintenance work should be done by qualified personnel familiar with the construction, operation, and hazards involved with the equipment. The appropriate work practices of NFPA 70E should be followed.

Product Compliance

Product Compliance Information

For your quick reference, product certification information can be found at the following URL (http://www.ab.com/certification/http://www.ab.com/certification/) Actual product certification is indicated by the label(s) on the product and not by a listing on this web site or in product literature.

UL Certification

Generally, Rockwell Automation pursues applicable UL certification for its products. There are four relevant types of certification granted by Underwriters Laboratories (UL):

- UL Recognized or Recognized to Canadian safety requirements under the Component Recognition Program of Underwriters Laboratories, Inc.:

Actual UL recognition is indicated by the label on the product, and not by statements in this catalog or any product literature.

- UL Listed, UL Listed to Canadian, or UL Listed to US and Canadian safety standards.

Actual UL listing is indicated by the label on the product, and not by statements in this catalog or any product literature.

CSA Certification

Generally, Rockwell Automation pursues applicable CSA certification for its products. CSA certifies products for general use as well as for use in hazardous locations. Products in this catalog might be certified in one of these two ways:

- CSA Class I, Division 2 Hazardous Location Certification: This product is listed by the Canadian Standards Association as certified for use in Class I, Division 2, Group A, B, C, D, or non-hazardous locations only.

Class I Div 2 Hazardous

Although Rockwell Automation is only using the Class I Division 2 Group A, B, C, D designation on its products, it should be noted that this hazardous location classification is equivalent to the internationally defined Class I Zone 2 Group IIC area classification (see IEC publication 79-10). Therefore, products labeled Class I Division 2 Group A, B, C, D may be used in Class I Zone 2 Group IIC environments.

- CSA Certification: The product is certified by the Canadian Standards Association for non-hazardous locations.

NRTL/C

Actual CSA certification is indicated by the label on the product, and not by statements in this catalog or any product literature.

ISO 9001 Registration

Rockwell Automation has registered facilities encompassing more than 45 separate sites around the world to the ISO 9001 standard. This registration means that its quality system governing the design, development, manufacture, and delivery of its products has been verified by third-party audits.

DEMKO Certification

A limited number of Allen-Bradley branded products have DEMKO certification. DEMKO certifies products for general use as well as hazardous locations. As a Notified Body for the European Hazardous Location Directives, DEMKO verifies that products comply with the applicable European directives and standards for use in hazardous locations. Refer to the specific product nameplate for the actual hazardous location rating.

CENELEC Intrinsically Safe (IS) Approval

A limited number of Allen-Bradley branded products have CENELEC IS Approval. CENELEC approves products for use in hazardous locations.

Actual CENELEC Approval is indicated by the label on the product, and by statements in the installation publication for the product.

Compliance with European Union Directives

Allen-Bradley branded products covered by European Union Directives are intended for sale and use within the European market and conform to the essential requirements of these directives:

- Products specifically required to do so bear the CE marking per the relevant European Union Directives and CE marking regulations
- Declarations of Conformity for Allen-Bradley branded products are available as required
- The necessary technical documentation is on file within Rockwell Automation

Actual CE conformity is indicated by the label on the product or its packaging, and not by statements in this catalog or any product literature.

C-tick Compliance

Allen-Bradley branded products covered by Australian acts are intended for sale and use within the Australian market and conform with the essential requirements of these acts. Declarations of Conformity for Allen-Bradley branded products are available as required.

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Actual C-Tick conformity is indicated by the label on the product, and not by statements in this catalog or any product literature.

FM Approved

A limited number of Allen-Bradley branded products have Factory Mutual Approval. FM approves products for general use as well as for use in hazardous locations. Products in this catalog may be FM Approved in one of these two ways:

- FM Class I Division 2 Hazardous Location Approval: The product is approved by Factory Mutual Research Corporation for use in Class I, Division 2, Group A, B, C, and D, or non-hazardous locations only.

Class I, Division 2, Group A, B, C, D

- FM Approval: The product is approved by Factory Mutual Research Corporation for use with specific FM Approved Class I, Division 2 products.

APPROVED

Actual FM Approval is indicated by the label on the product, and not by statements in this catalog or any product literature.

ControlNet Conformance

ControlNet International's "Conformance Tested" certification mark is a ControlNet International logo, the authorized use of which indicates that a product has passed conformance testing at an official ControlNet International test lab.

DeviceNet Conformance

The DeviceNet conformance-tested service mark may be placed on a product, its literature, and/or advertising, only after it has successfully passed conformance testing at an official independent test lab of the Open DeviceNet Vendor Association.

Certification for Marine and Off-Shore Applications

If a product or its packaging has a certification for marine and off-shore applications, it is listed in the Marine Certification Applications publication CIG-2.2.
Many Allen-Bradley branded products, such as selected PLC-5 programmable controllers, 1771 I/O, and Dataliner Message Displays, have been certified for use in marine and offshore applications around the world by

- Lloyd's Register
- Registoro Italiano Navale
- Germanischer Lloyd
- Korean Register of Shipping
- American Bureau of Shipping
- Bureau Veritas
- Det Norske Veritas

Contacting Standards Organizations

Use the addresses and phone numbers below to contact the organizations regarding standards that may impact the installation, application and/or interoperability of Allen-Bradley branded products.

American National Standards Institute (ANSI)
Sales Department
11 West 42nd Street
New York, NY 10036
Phone: 212-642-4900
Fax: 212-398-0023
URL:http://www.ansi.org/ http://www.ansi.org/

CSA International
178 Rexdale Boulevard
Etobicoke (Toronto), ON M9W 1R3
Phone: 416-747-4058
Fax: 416-747-4149
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National Fire Protection Association (NFPA)
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National Institute of Standards and Technology (NIST)
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Specify the Correct Enclosure for your Motor Controls

Type 1 General Purpose Surface Mounting

Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment in locations where unusual service conditions do not exist. The enclosures are designed to meet the rod entry and rust-resistance design tests. Enclosure is sheet steel, treated to resist corrosion.

Type 1 Flush Mounting

Type 1 Flush mounting enclosures for installation in machine frames and plaster wall. These enclosures are for similar applications and are designed to meet the same tests as Type 1 surface mounting.

Type 3 Rainproof Dusttight

Type 3 enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain and sleet; and to be undamaged by the formation of ice on the enclosure. They are designed to meet rain∗, external icing†, dust, and rust-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 3R Rainproof

Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain, and to be undamaged by the formation of ice on the enclosure. They are designed to meet rod entry, rain‡, external icing†, and rust-resistance design tests. They are not intended to provide protection against conditions such as dust, internal condensation, or internal icing.

Type 4 Watertight

Type 4 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure. They are designed to meet hosedown, dust, and external icing tests†. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 4X Non-Metallic, Corrosion- Resistant

Type 4X enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure. They are designed to meet the hosedown, dust, external icing†, and corrosion-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

∗ Evaluation criteria: No water has entered enclosure during specified test.
† Evaluation criteria: Undamaged after ice buildup during specified test has melted (Note: Not required to be operable while ice-laden).
‡ Evaluation criteria: No water shall have reached live parts, insulation or mechanisms.

NEMA Enclosures

ENCLOSURES
Refer to the brief descriptions below for the various types of enclosures offered by Allen-Bradley. **See pages Important-9 and Important-10 for selection criteria.** For definitions, descriptions and test criteria, see National Electrical Manufacturers Association (NEMA) Standards Publication No. 250. Also see individual product listings within the Allen-Bradley catalog for available enclosure types and for any additional information relating to these descriptions.

NOTE: Enclosures do not normally protect devices against conditions such as condensation, icing, corrosion or contamination that may occur within the enclosure or enter via the conduit or unsealed openings. Users must make adequate provisions to safeguard against such conditions and satisfy themselves that the equipment is properly protected.

Type 7 & 9 Bolted Enclosure for Hazardous Locations

Type 7 & 9 Unilock Enclosure for Hazardous Locations

Type 7 For Hazardous Gas Locations

Type 7 enclosures are for indoor use in locations classified as Class I, Groups C or D, as defined in the U.S. National Electrical Code. Type 7 enclosures are designed to be capable of withstanding the pressures resulting from an internal explosion of specified gases, and contain such an explosion sufficiently that an explosive gas-air mixture existing in the atmosphere surrounding the enclosure will not be ignited. Enclosed heat generating devices are designed not to cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in the surrounding atmosphere. Enclosures are designed to meet explosion, hydrostatic, and temperature design tests. Finish is a special corrosion-resistant, gray enamel.

Type 9 For Hazardous Dust Locations

Type 9 enclosures are intended for indoor use in locations classified as Class II, Groups E, F, or G, as defined in the U.S. National Electrical Code. Type 9 enclosures are designed to be capable of preventing the entrance of dust. Enclosed heat generating devices are designed not to cause external surfaces to reach temperatures capable of igniting or discoloring dust on the enclosure or igniting dust-air mixtures in the surrounding atmosphere. Enclosures are designed to meet dust penetration and temperature design tests, and aging of gaskets. The outside finish is a special corrosion-resistant gray enamel.

Type 6P For Prolonged Submersion at a Limited Depth

Type 6P enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against the entry of water during prolonged submersion at a limited depth; and to be undamaged by the formation of ice on the enclosure. They are designed to meet air pressure, external icing*, hosedown and corrosion-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 12 Dusttight Industrial Use

Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids. They are designed to meet drip†, dust, and rust-resistance tests. They are not intended to provide protection against conditions such as internal condensation.

Type 13 Oiltight

Type 13 enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant. They are designed to meet oil exclusion and rust-resistance design tests. They are not intended to provide protection against conditions such as internal condensation.

* Evaluation criteria: Undamaged after ice buildup during specified test has melted (Note: Not required to be operable while ice-laden).
† Evaluation criteria: No water has entered enclosure during specified test.

Enclosure Selection Criteria

Enclosures for Non-Hazardous Locations

For a Degree of Protection Against:	Designed to Meet Tests No. ∗	Type							
		For Indoor Use			Outdoor Use		Indoor or Outdoor		
		1	12	13	3R	3	4	4X	6P
Incidental contact with enclosed equipment	6.2	✓	✓	✓	✓	✓	✓	✓	✓
Falling dirt	6.2	✓	✓	✓	✓	✓	✓	✓	✓
Rust	6.8	✓	✓	✓	✓	✓	✓	✓	✓
Circulating dust, lint, fibers and flyings †	6.5.1.2 (2)		✓	✓		✓	✓	✓	✓
Windblown dust	6.5.1.1 (2)					✓	✓	✓	✓
Falling liquids and light splashing	6.3.2.2		✓	✓		✓	✓	✓	✓
Rain (Test evaluated per 6.4.2.1)	6.4.2.1				✓	✓	✓	✓	✓
Rain (Test evaluated per 6.4.2.2)	6.4.2.2					✓	✓	✓	✓
Snow and sleet	6.6.2.2				✓	✓	✓	✓	✓
Hosedown and splashing water	6.7						✓	✓	✓
Occasional prolonged submersion	6.11 (2)								✓
Oil and coolant seepage	6.3.2.2		✓	✓					
Oil or coolant spraying and splashing	6.12			✓					
Corrosive agents	6.9				✓	✓	✓	✓	✓

∗ See below for abridged description of NEMA enclosure test requirements. Refer to NEMA Standards Publication No. 250 for complete test specifications.
† Non-hazardous materials, not Class III ignitable or combustible.

Abridged Description of NEMA Enclosure Test Requirements

6.2 Rod Entry Test — A 1/8 in (3.18 mm) diameter rod must not be able to enter enclosure except at locations where nearest live part is more than 4 in (102 mm) from an opening — such opening shall not permit a 1/2 in (13 mm) diameter rod to enter.

6.3 Drip Test — Water is dripped onto enclosure for 30 minutes from an overhead pan having uniformly spaced spouts, one every 20 sq in (12900 mm^2) of pan area, each spout having a drip rate of 20 drops per minute. Evaluation 6.3.2.2: No water shall have entered enclosure.

6.4 Rain Test — Entire top and all exposed sides are sprayed with water at a pressure of 5 psi (0.35 kg/cm^2) from nozzles for one hour at a rate to cause water to rise 18 in (457 mm) in a straight-sided pan beneath the enclosure. Evaluation 6.4.2.1: No water shall have reached live parts, insulation or mechanisms.

Evaluation 6.4.2.2: No water shall have entered enclosure.

6.5.1.1 (2) Outdoor Dust Test (Alternate Method) — Enclosure and external mechanisms are subjected to a stream of water at 45 gallons (170.5 liters) per minute from a 1 in (25.4 mm) diameter nozzle, directed at all joints from all angles from a distance of 10 to 12 feet (3 to 3.7 meters). Test time is 48 seconds times the test length (height + width + depth of enclosure in feet), or a minimum of 5 minutes. No water shall enter enclosure.

6.5.1.2 (2) Indoor Dust Test (Alternate Method) — Atomized water at a pressure of 30 psi (2.11 kg/cm^2) is sprayed on all seams, joints and external operating mechanisms from a distance of 12 to 15 in (305 to 381mm) at a rate of 3 gallons (11 liters) per hour. No less than 5 ozs (142 gms) of water per linear foot of test length (height + length + depth of enclosure) is applied. No water shall enter enclosure.

6.6 **External Icing Test** — Water is sprayed on enclosure for one hour in a cold room 35.6 °F (+2 °C); then room temperature is lowered to approximately –23 °F (–5 °C) and water spray is controlled so as to cause ice to build up at a rate of 1/4 in (6.4 mm) per hour until 3/4 in (19 mm) thick ice has formed on top surface of a 1 in (25.4 mm) diameter metal test bar, then temperature is maintained at –23 °F (–5 °C) for 3 hours.

Evaluation 6.6.2.2: Equipment shall be undamaged after ice has melted (external mechanisms not required to be operable while ice-laden).

6.7 **Hosedown Test** — Enclosure and external mechanisms are subjected to a stream of water at 65 gallons (246 liters) per minute from a 1 in (25.4 mm) diameter nozzle, directed at all joints from all angles from a distance of 10 to 12 ft (3 to 3.7 meters). Test time is 48 seconds times the test length (height + width + depth of enclosure in ft) (meters), or a minimum of 5 seconds. No water shall enter enclosure.

6.8 **Rust Resistance Test (Applicable Only to Enclosures Incorporating External Ferrous Parts)** — Enclosure is subjected to a salt spray (fog) for 24 hours, using water with five parts by weight of salt (NaCl), at 95 °F (35 °C), then rinsed and dried. There shall be no rust except where protection is impractical (e.g., machined mating surfaces, sliding surfaces of hinges, shafts, etc.).

6.9 **Corrosion Protection** — Sheet steel enclosures are evaluated per Underwriter's Laboratories (UL) 50, Part 13 (test for equivalent protection as G-90 commercial zinc coated sheet steel). Other materials per Underwriter's Laboratories (UL) 508, 6.9 or 6.10.

6.11 (2) **Air Pressure Test (Alternate Method)** — Enclosure is submerged in water at a pressure equal to water depth of 6 ft (2 meters), for 24 hours. No water shall enter enclosure.

6.12 **Oil Exclusion Test** — Enclosure is subjected to a stream of test liquid for 30 minutes from a 3/8 in (9.5 mm) diameter nozzle at 2 gallons (7.57 liters) a minute. Water with 0.1% wetting agent is directed from all angles from a distance of 12 to 18 in (305 to 457 mm), while any externally operated device is operated at 30 operations per minute. No test liquid shall enter the enclosure.

Enclosure Selection Criteria, Continued

Enclosures for Hazardous Locations (Division 1 or 2)*

For a Degree of Protection Against Atmospheres Typically Containing: ‡	Designed to Meet Tests †	Class (National Electrical Code)	Type						
			7, Class I Group				9, Class II Group		
			A	B	C	D	E	F	G
Acetylene	Explosion Test	I	✓						
Hydrogen, Manufactured Gas	Hydrostatic Test	I	✓	✓					
Diethyl Ether, Ethylene, Hydrogen Sulfide		I			✓				
Acetone, Butane, Gasoline, Propane, Toluene	Temperature Test	I			✓	✓			
Metal dusts and other combustible dusts with resistivity of less than 10^5 ohm-cm.	Dust Penetration Test	II					✓		
Carbon black, charcoal, coal or coke dusts with resistivity between 10^2…10^8 ohm-cm		II						✓	
Combustible dusts with resistivity of 10^5 ohm-cm or greater	Temperature Test with Dust Blanket	II							✓
Fibers, flyings	§	III							✓

* For indoor locations only unless cataloged with additional NEMA Type enclosure number(s) suitable for outdoor use as shown in table on page Important-9. Some control devices (if so listed in the catalog) are suitable for Division 2 hazardous location use in enclosures for non-hazardous locations. For explanation of CLASSES, DIVISIONS and GROUPS, refer to the National Electrical Code.
Note: Classifications of hazardous locations are subject to the approval of the authority having jurisdiction. Refer to the National Electrical Code.

† See abridged description of test requirements below. For complete requirements, refer to UL Standard 698, compliance with which is required by NEMA enclosure standards.

‡ For listing of additional materials and information noting the properties of liquids, gases and solids, refer to NFPA 497M-1991, Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations.

§ UL 698 does not include test requirements for Class III. Products that meet Class II, Group G requirements are acceptable for Class III.

Abridged Description of UL Standard 698 Test Requirements

Explosion Test — During a series of tests in which gas-air mixtures of the specific gas, over its range of explosive concentrations, are ignited inside the enclosure, the enclosure shall prevent the passage of flame and sparks capable of igniting a similar gas-air mixture surrounding the enclosure. In addition, there shall be no mechanical damage to enclosed electrical mechanisms or the enclosure.

Hydrostatic Test — The enclosure shall withstand for 1 minute a hydrostatic test based on the maximum internal explosion pressure developed during the explosion tests, as follows: cast metal, four times the explosion pressure without rupture or permanent deformation; fabricated steel, twice the explosion pressure without permanent deformation and three times the explosion pressure without rupture. Exception: Hydrostatic tests may be omitted if calculations show safety factor of 5:1 for cast metal and 4:1 for fabricated steel.

Temperature Test — The enclosed device is subjected to a temperature test to determine maximum temperature at any point on the external surface. The device must be marked with a temperature code based on the result only if the temperature exceeds (+212 °F) +100 °C.

Dust Penetration Test — The device is operated at full rated load until equilibrium temperatures are attained, then allowed to cool to ambient (room) temperature, through six heating and cooling cycles covering at least 30 hours, while continuously exposed to circulating dust of specified properties in a test chamber. No dust shall enter the enclosure.

Temperature Test with Dust Blanket
This test is conducted as described for the Dust Penetration test except that the recirculating dust nozzles are positioned so that the dust is not blown directly on the device under test. The device is operated at full rated load (and under abnormal conditions for equipment subject to overloading) until equilibrium temperatures are attained. Dust in contact with the enclosure shall not ignite or discolor from heat, and the exterior temperatures based on (+104 °F) +40 °C ambient shall not exceed:

Group	Normal Operation	Abnormal Operation
E	(+392 °F) +200 °C	(+392 °F) +200 °C
F	(+302 °F) +150 °C	(+392 °F) +200 °C
G	(+248 °F) +120 °C	(+329 °F) +165 °C

Degree of Protection

IEC Publication 529 describes standard Degrees of Protection that enclosures of a product are designed to provide when properly installed.

Summary

The publication defines degrees of protection with respect to:

- Persons
- Equipment within the enclosure
- Ingress of water

It does **not** define:

- Protection against risk of explosion
- Environmental protection (e.g. against humidity, corrosive atmospheres or fluids, fungus or the ingress of vermin)

Note: The IEC test requirements for Degrees of Protection against liquid ingress refer only to water. Those products in this catalog, which have a high degree of protection against ingress of liquid, in most cases include Nitrile seals. These have good resistance to a wide range of oils, coolants and cutting fluids. However, some of the available lubricants, hydraulic fluids and solvents can cause severe deterioration of Nitrile and other polymers. Some of the products listed are available with seals of Viton or other materials for improved resistance to such liquids. For specific advice on this subject refer to your local Allen-Bradley Sales Office.

IEC Enclosure Classification

The degree of protection is indicated by two letters (IP) and two numerals. International Standard IEC 529 contains descriptions and associated test requirements that define the degree of protection each numeral specifies. The following table indicates the *general* degree of protection — refer to Abridged Descriptions of IEC Enclosure Test Requirements below and on page Important-11. **For complete test requirements refer to IEC 529.**

First Numeral*	Second Numeral*
Protection of persons against access to hazardous parts and protection against penetration of solid foreign objects.	Protection against ingress of water under test conditions specified in IEC 529.
0 Non-protected	0 Non-protected
0.Back of hand; objects greater than 50 mm in diameter	0.Vertically falling drops of water
0.Finger; objects greater than 12.5 mm in diameter	0.Vertically falling drops of water with enclosure tilted 15 degrees
0.Tools or objects greater than 2.5 mm in diameter	0.Spraying water
0.Tools or objects greater than 1.0 mm in diameter	0.Splashing water
0.Dust-protected (dust may enter during specified test but must not interfere with operation of the equipment or impair safety)	0.Water jets
0.Dusttight (no dust observable inside enclosure at end of test)	0.Powerful water jets
	0.Temporary submersion
	0.Continuous submersion
Example: IP41 describes an enclosure that is designed to protect against the entry of tools or objects greater than 1 mm in diameter and to protect against vertically dripping water under specified test conditions.	
Note: All first numerals and second numerals up to and including characteristic numeral 6, imply compliance also with the requirements for all lower characteristic numerals in their respective series (first or second). Second numerals 7 and 8 do not imply suitability for exposure to water jets (second characteristic numeral 5 or 6) unless dual coded; e.g., IP_5/IP_7.	

* The IEC standard permits use of certain supplementary letters with the characteristic numerals. If such letters are used, refer to IEC 529 for the explanation.

Abridged Descriptions of IEC Enclosure Test Requirements

(Refer to IEC 529 for complete test specifications — e.g., test apparatus configuration; tolerances; etc. For Metric Conversion factors — see page Important-2.)

Tests for Protection Against Access to Hazardous Parts (first characteristic numeral)

The first characteristic numeral of the IP number indicates compliance with the following tests for the degree of protection against access to hazardous parts. It also indicates compliance with tests as shown in the next section for the degree of protection against solid foreign objects.

The protection against access to hazardous parts is satisfactory if adequate clearance is kept between the specified access probe and hazardous parts. For voltages less than 1000V AC and 1500V DC, the access probe must not touch the hazardous live parts. For voltages exceeding 1000V AC and 1500V DC, the equipment must be capable of withstanding specified dielectric tests with the access probe in the most unfavorable position.

IP0_ — No test required.

IP1_ — A rigid sphere 50 mm in diameter shall not completely pass through any opening. Force = 50 N.

IP2_ — A jointed test finger 80 mm long and 12 mm in diameter may penetrate to its 80 mm length, but shall have adequate clearance as specified above, from hazardous live parts, in every possible position of the test finger as both joints are bent through an angle up to 90°. Force = 10 N.

IP3_ — A test rod 2.5 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified above). Force = 3 N.

IP4_ — A test wire 1 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified above). Force = 1 N.

IP5_ — A test wire 1 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified on page Important-11). Force = 1 N.

IP6_ — A test wire 1 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified on page Important-11). Force = 1 N.

Tests for Protection Against Solid Foreign Objects (first characteristic numeral)

For first numerals **1**, **2**, **3**, and **4** the protection against solid foreign objects is satisfactory if the full diameter of the specified probe does not pass through any opening. Note that for first numerals **3** and **4** the probes are intended to simulate foreign objects which may be spherical. Where shape of the entry path leaves any doubt about ingress or a spherical object capable of motion, it may be necessary to examine drawings or to provide special access for the object probe. For first numerals **5** and **6** see test descriptions below for acceptance criteria.

IP0_ — No test required.

IP1_ — The full diameter of a rigid sphere 50 mm in diameter must not pass through any opening at a test force of 50 N.

IP2_ — The full diameter of a rigid sphere 12.5 mm in diameter must not pass through any opening at a test force of 30 N.

IP3_ — A rigid steel rod 2.5 mm in diameter must not pass through any opening at a test force of 3 N.

IP4_ — A rigid steel wire 1 mm in diameter must not pass through any opening at a test force of 1 N.

IP5_ — The test specimen is supported inside a specified dust chamber where talcum powder, able to pass through a square-meshed sieve with wire diameter 50 mm and width between wires 75 mm, is kept in suspension.

Enclosures for equipment subject to thermal cycling effects (category 1) are vacuum pumped to a reduced internal pressure relative to the surrounding atmosphere: maximum depression = 2 kPa; maximum extraction rate = 60 volumes per hour. If extraction rate of 40 to 60 volumes/h is obtained, test is continued until 80 volumes have been drawn through or 8 h has elapsed. If extraction rate is less than 40 volumes/h at 20 kPa depression, test time = 8 h.

Enclosures for equipment not subject to thermal cycling effects **and** designated category 2 in the relevant product standard are tested for 8 h without vacuum pumping.

Protection is satisfactory if talcum powder has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the equipment or impair safety; and no dust has been deposited where it could lead to tracking along creepage distances.

IP6_ — All enclosures are tested as category 1, as specified above for IP5_. The protection is satisfactory if no deposit of dust is observable inside the enclosure at the end of the test.

Tests for Protection Against Water (second characteristic numeral)

The second characteristic numeral of the IP number indicates compliance with the following tests for the degree of protection against water. For numerals **1** through **7**, the protection is satisfactory if any water that has entered does not interfere with satisfactory operation, does not reach live parts not designed to operate when wet, and does not accumulate near a cable entry or enter the cable. For second numeral **8** the protection is satisfactory if no water has entered the enclosure.

IP_0 — No test required.

IP_1 — Water is dripped onto the enclosure from a “drip box” having spouts spaced on a 20 mm square pattern, at a “rainfall” rate of 1 mm/min. The enclosure is placed in its normal operating position under the drip box. Test time = 10 min.

IP_2 — Water is dripped onto the enclosure from a “drip box” having spouts spaced on a 20 mm square pattern, at a “rainfall” rate of 3 mm/min. The enclosure is placed in 4 fixed positions tilted 15° from its normal operating position, under the drip box. Test time = 2.5 min. for each position of tilt.

Tests for Protection Against Access to Hazardous Parts (second characteristic numeral)

IP_3 — Water is sprayed onto all sides of the enclosure over an arc of 60° from vertical, using an oscillating tube device with spray holes 50 mm apart (or a hand-held nozzle for larger enclosures). Flow rate, oscillating tube device = 0.07 l/min. per hole x number of holes; for hand-held nozzle = 10 l/min. Test time, oscillating tube = 10 min.; for hand-held nozzle = 1 min./m^2 of enclosure surface area, 5 min. minimum.

IP_4 — Same as test for **IP_3** except spray covers an arc of 180° from vertical.

IP_5 — Enclosure is sprayed from all practicable directions with a stream of water at 12.5 l/min. from a 6.3 mm nozzle from a distance of 2.5 to 3 m. Test time = 1min./m^2 of enclosure surface area to be sprayed, 3 min. minimum.

IP_6 — Enclosure is sprayed from all practicable directions with a stream of water at 100 l/min. from a 12.5 mm nozzle from a distance of 2.5 to 3 m. Test time = 1min./m^2 of enclosure surface area to be sprayed, 3 min. minimum.

IP_7 — Enclosure is immersed in water in its service position for 30 min. Lowest point of enclosures less than 850 mm tall = 1000 mm below surface of water. Highest point of enclosures more than 850 mm tall = 150 mm below surface of water.

IP_8 — Test conditions are subject to agreement between manufacturer and user, but shall be at least as severe as those for **IP_7**.