Texas Instruments General Quality Guidelines

Texas Instruments (TI) is dedicated to designing, manufacturing and marketing high quality integrated circuit products that serve our customers' needs. TI's dedicated Quality organization includes customer Quality representatives in each TI business segment, who work closely with our customers to quickly resolve quality related issues by coordinating efforts and communicating with TI business segments, sales and manufacturing teams. Customer quality representatives also support communication regarding, product containment, corrective action, and quality improvement programs.

In an effort to meet our customers' quality data requirements, TI recently updated its Quality and Reliability website at ti.com/quality. The new site contains useful information, including:

- TI's Quality Policies and Procedures;
- Environmental Policies and Statements;
- Product Shelf Life;
- Reliability; and
- Certifications and Industry Standards.

TI's commitment to customer satisfaction is communicated through the TI Quality Policy:

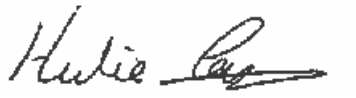
Our quality policy

Quality is foundational to achieving our business objectives. We are committed to satisfying applicable requirements and providing quality products to customers around the world by:

- Encouraging and expecting the creative involvement of every TI'er
- Listening to our customers
- Continuously improving and innovating our products, processes and services

TI sites first achieved the International Organization for Standardization´s (ISO) Quality Management System (ISO 9001) and Environmental Management System (ISO 14001) Certifications in 1996 and have maintained compliance with the ISO requirements since that time. Texas Instruments is also certified to the following standards:

- IATF 16949 certified in 2018 (Global automotive industry).
- OHSAS 18001 certification in 2007 (Occupational health and safety).



Hubert J. Payne
Vice President of Worldwide SC Quality

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1 SCOPE

The General Quality Guidelines (GQG) apply to the provision of quality assurance with respect to materials, products, services, manufacturing processes, tests, controls, handling, storage and transport measures as well as the management processes used and/or applied by TI so that Products will comply with the published and/or specifically agreed specifications. “TI Products” are packaged integrated circuit products that TI has qualified as released to market.

TI will endeavor to comply fully with these guidelines; however, nothing in this document shall be construed to create, expand or in any way alter any warranties or remedies, if any, as set forth in TI's applicable terms of sale.

TI works hard to follow these quality practices and seeks to provide customers with the most accurate and up to date information available about its general quality practices. Although the information provided herein is true and accurate as of the latest revision of this document, TI may occasionally make changes or updates.

2 QUALITY MANAGEMENT SYSTEM

TI’s Quality Policy Manual has been written to meet the requirements of our customers as well as applicable International and National Standards such as International Standardization Organization (ISO) 9001 and IATF16949. It is supported by documented procedures, work instructions, and process flows that define specific activities needed to implement the quality management system and the quality policy. This documentation describes the interaction between the processes of TI’s quality management system.

3 MANAGEMENT RESPONSIBILITY

Top management is committed to the implementation and continual improvement of TI quality systems as a critical method for product realization and customer support. Top management and other management as appropriate regularly review the effectiveness and efficiency of the quality system, and make the necessary adjustments to meet planned objectives and customer expectations.

4 INTERESTED PARTIES

TI considers interested parties as entities with applicable requirements or expectations that, if not addressed, could raise the risk level on the organization and negatively impact its ability to achieve its intended results. Interested parties include external and internal customers, suppliers, and governmental organizations that publish statutory and regulatory requirements. TI monitors and reviews information of interested parties and their relevant requirements.

To determine risks and opportunities TI considers:

- The relevant external and internal issues that can affect the ability to achieve the intended results; and
- The interested parties and their requirements which are relevant to TI’s Quality Management System and to its products and services.

5 AUDITS

Periodic internal audits are performed to ensure compliance to stated requirements, the effective implementation and operation of the quality management system, and the identification of opportunities for continual improvement. Audits are conducted at planned intervals and are performed by qualified internal auditors independent of the area being assessed. A process is in place to ensure qualified internal assessors are used. Results of audits are documented and corrective actions are implemented and evaluated for effectiveness. Audit results form part of the management review process.

TI’s supplier quality system assessment is addressed in the Purchasing and Supplier Management section. Occasionally, customers may ask to verify Product at one of TI’s supplier sites. TI manages these requests on a case-by-case basis and coordinates with the supplier, as appropriate.

TI endeavors to satisfy customer audit requests related to the effective performance of our Quality Management System in a number of different ways. All TI manufacturing sites are certified to ISO9001:2015 and IATF 16949:2016. ISO and IATF certificates are available on ti.com. Requests for individual customer audits are formally reviewed in a timely manner via a structured process. However, it is not possible to accept all such requests.

6 PURCHASING AND SUPPLIER MANAGEMENT

The quality of TI Products is dependent on the quality of purchased materials and services. TI requires suppliers of critical materials and services to develop, implement, and improve a quality management system certified to ISO 9001 and other applicable quality management system standards.

The purchase process is documented and structured to meet the following requirements:

- Ensure that purchasing documents clearly describe the Product and services ordered
- Ensure that purchased products and services conform to purchase requirements
- Communicate to suppliers the appropriate product, quality, and delivery requirements
- Ensure that purchased materials and services meet government, safety, and environmental regulations
- Ensure that finished product, direct materials, and packing materials meet the provisions of regulatory and agreed upon customer requirements

All TI groups/organizations utilizing purchased materials and services will work with the established supplier management organizations, as applicable; to ensure that the supplier management process in place is structured to cover the following:

- Identify and select suppliers with the capability to meet TI needs
- Establish criteria for selection, evaluation, qualification, and certification of suppliers
- Perform supplier quality management system development
- Ensure continuity of supply
- Ensure that critical materials and services are purchased only from approved sources
- Monitor and provide feedback on supplier performance
- Monitor product quality and delivery performance (including use of premium freight, as applicable)

7 CYBERSECURITY

Texas Instruments employs a global, dedicated IT Security team to deploy policies, processes, and technologies to protect TI's intellectual property and other interests. TI's information security policies combine elements from security policies and standards published by groups such as ISO, NIST, and other authoritative sources and apply them to TI's business environment.

To protect the value of our security investments, TI does not generally disclose specific details on people, processes, or technologies relating to information security practices.

8 ANTI-COUNTERFEIT

Counterfeits pose considerable performance, safety, and reliability risks. To help mitigate this risk, TI strongly recommends our customers purchase either directly from TI, an authorized distributor or authorized reseller.
TI works actively with Semiconductor Industry Association and other industry organizations to combat counterfeiting, advance industry standards that will help reduce the incidence of counterfeits and assist law enforcement agencies in their efforts to address this challenge.

9 EXTERNAL CALIBRATION LABORATORIES

The external calibration laboratories that Texas Instruments chooses to use must be approved based on their accreditation or their status as an Original Equipment Manufacturer. When supporting IATF 16949 certified sites, external calibration laboratories will be certified to ISO 17025 or national equivalent.

10 PRODUCT DEVELOPMENT

All new Product development at TI follows a structured new product development process such as Product Quality Planning, and/or Product Realization as applicable. A phase review system for each group is defined in controlled documented procedures. A formal project review and approval, by responsible management, is completed and documented at critical points in the development process. The process is designed to manage organizational interfaces,

project risks, schedule (including sample delivery, and qualification documentation) and communication between groups involved in the development process.

11 RISK MANAGEMENT

Risk evaluation and mitigation is a fundamental part of TI's Quality Management System. TI uses risk management as part of new Product development and manufacturing. Examples of these strategies and methodologies include: Phased gated New Product Development (NPD), project risk assessments, Business Continuity Planning (BCP), Product qualification and characterization methodologies and change management risk strategies. Other risk management considerations including but not limited to functional safety and safety critical applications may be utilized and will depend upon the specific TI Product requirements. TI maintains applicable manufacturing risk management summaries on file at TI facilities.

12 QUALIFICATION / RELIABILITY

Quality and reliability are built into TI's culture, with the goal of providing customers high quality Products. TI's semiconductor technologies are developed with a minimum capability of 100,000 Power-On-Hours at 105°C junction temperature. TI builds simulations, accelerated testing, and robustness evaluations into the Product development process. During the Product development process, TI carefully assesses silicon process reliability, package reliability, and silicon/package interaction. TI also evaluates manufacturability of the Product to verify a robust silicon and assembly flow to enable continuity of supply to customers.

TI Products are qualified with industry standard test methodologies performed primarily to the intent of the Joint Electron Devices Engineering Council (JEDEC). Other standards (e.g. IPC/MIL/ANSI) may be used when appropriate. TI performs enhanced reliability testing for particular parts in accordance with the requirements of the military standards that would be specific to the intended environmental conditions that are anticipated for field application of the Product. Qualification test results for HiRel Defense and Aerospace Products are made available to customers upon request.

13 PROCESS MONITORING / PRODUCT ASSURANCE

TI uses process measurement and monitoring for manufacturing process control and to minimize process and Product variation with a goal to achieve zero defects. Important characteristics are identified, data is analyzed, and statistical process control (SPC) is used in all phases of manufacturing with an emphasis on defect prevention versus detection.

Automated systems are applied for Product statistical yield outlier (SYL) and standard statistical bin outlier (SBL) with quarterly limit recalculation, where applicable. Additional statistical based controls may be available for specific design and process technology that is based on business product engineering.

TI manufacturing uses process capability measurements as a key component of process monitoring and control with a goal to achieve values of $Cp > 2.00$ and $Cpk > 1.67$. Measurement systems used for process monitoring are controlled by using established qualification, verification and calibration procedures. TI manufacturing operators and specialists are trained to use and employ statistical control processes and procedures as an additional component of process monitor and control.

A test of outgoing Product is included as part of process and product monitoring. This monitoring may include inline parametric, functional, visual verification utilizing statistical and product outlier control methods. Samples (such as "golden" samples) may also be used as references for the manufacturing process and final Products.

14 MEASUREMENT SYSTEM ANALYSIS (MSA)

Accurate and precise measurement systems are used to ensure that Products are compliant to specification and agreed upon customer requirements. Measurement system gage repeatability and reproducibility (GRR) verification is performed to ensure measurement system performance meets expectations.

15 ELECTROSTATIC DISCHARGE (ESD)

All TI operations worldwide that handle, test, or ship ESD sensitive devices or assemblies containing such devices employ electrostatic discharge prevention methods or procedures. TI adheres to an industry standard ESD control program, JEDEC JESD625.

16 SOFTWARE QUALITY ASSURANCE

All TI operations responsible for the development of software products or related services will document their activity requirements which include: the integrity of the development process, continuous compliance to customer requirements, base-lining software products and maintaining their revision status, and quality control activities.

17 CONTINUAL IMPROVEMENT

TI conducts periodic reviews of the effectiveness of the entire quality management system and changes that could affect the quality management system. These reviews include monitoring trends in operational, business, customer feedback and quality performance of the Products realization processes and the associated support processes.

Metrics are defined for key performance areas and are used to monitor ongoing progress to quality objectives, to identify critical issues, to track improvement activities, to identify and prioritize opportunities for quality and productivity improvements and to measure cost of poor quality, as applicable. Organizational resources are analyzed against quality objectives for suitability. Data and information from all sources of Product and process issues, including analysis of field failures and other customer feedback as applicable, are also reviewed to identify areas where action may need to be taken to reduce or eliminate nonconforming product and to prevent potential issues from occurring.

TI's continuous improvement processes includes:

- 5S Activities
- Defect Reduction
- Additional testing and inspection
- Problem solving programs
- Lessons learned and fan out

18 NONCONFORMING PRODUCTS

In the event that TI discovers that nonconforming goods were delivered to a customer, TI will inform the customer or distributor in a reasonable time of this regard in writing and will take reasonable measures in order to avoid and/or minimize damages.

If it becomes necessary to deliver Products to a customer and the Products do not comply with TI's datasheet or mutually agreed customer device specifications, TI will provide in advance, a waiver which documents this event and requires customer approval. This can be done in system-generated form without a signature.

19 NONCONFORMITY AND CORRECTIVE ACTION

When nonconformities occur in the process, Products, quality management system, or when customer complaints or returns are received, personnel will take immediate containment and appropriate correction and corrective action according to their documented procedures. Managers with responsibility and authority for corrective action will be promptly informed when Products or processes become noncompliant with specified requirements. Documented corrective action will include:

- Reviewing and documenting the problem
- Where Products is involved, preventing any additional defective product from being produced, and preventing any defective Products from being shipped to a customer
- Prompt customer notification when nonconforming Products has been shipped
- Investigating the root cause of the problem and recording the results of the investigation
- Utilizing problem solving and error proofing methods, as applicable, to determine appropriate corrective actions based on the root cause analysis
- Documenting and implementing the appropriate corrective actions
- Verifying that the corrective action is effective in eliminating the problem and preventing its recurrence

- Applying the corrective action to similar processes and products as appropriate

Additionally, data and information from quality management sources including Products and process problems are periodically analyzed to identify areas where action may be needed to prevent potential problems from occurring. According to documented procedures, appropriate actions are taken to initiate preventive actions and to ensure they are effective.

The documented preventive action will include:

- Determining potential nonconformities and their causes
- Evaluating if action is required to prevent the occurrence of potential nonconformities
- Documenting and implementing the appropriate preventive actions
- Documenting the results of the preventive action, and
- Reviewing the effectiveness of the preventive action
- Updating risk management methodologies

20 CUSTOMER RETURNS

In the event that a customer experiences issues or failures with a TI Product, including embedded software, TI has developed a process which allows customers to input return requests through the Customer Return Portal, (CRP). Once a request has been accepted a thorough and timely analysis of the reported problem will be undertaken, including execution of appropriate corrective action. Appropriate communication with customers and within TI will occur during-testing and analysis. For information on how to process returns, please access the above link or contact your sales representative or a TI authorized distributor.

21 CHANGE MANAGEMENT

After formal Product /process release, continual improvement strategies are emphasized, and as a result, there may be a need to modify, update, or discontinue the Product /process. When this occurs, the change management system is used to plan, qualify, and implement the change. Where practical, analysis is performed on potential impact to the systems in which the product/process is used and the effect of changes on Product already delivered.

A formal documented change process is used to ensure that the appropriate validations are completed and modifications documented prior to implementing the change. When a Product /process change requires customer notification, a formal Product change notification process is used. Records are kept indicating the initiation of any change to production processes and to demonstrate conformance to these requirements.

TI complies with the requirement in J-STD-046, latest issue for notification of Product changes. Consistent with this industry standard, customers will be notified of major changes which affect the form, fit, function, or adversely affect quality or reliability of the Product.

22 PRODUCT WITHDRAWAL/DISCONTINUANCE

TI's Product withdrawal/discontinuance process complies with J-STD-048, latest issue. TI makes an effort to not obsolete Products out of convenience. Convenience means: low running device, poor yields, limited customer adoption or similar items. TI's obsolescence withdrawal schedule provides a longer lead time than the industry standard. TI allows 12 months for the last order and an additional 6 months to take final delivery of obsolete items. In rare circumstances, an accelerated withdrawal schedule may be necessary. In such cases, TI will communicate the last buy and final delivery dates in the EOL notice, along with an explanation of the circumstances necessitating the early withdrawal.

23 BUSINESS CONTINUITY PROGRAM

TI has a Business Continuity Program that covers contingency planning, incident management, crisis management, customer response, and business recovery. TI Business Continuity Program protects TI's corporate interests by doing the following:

- Minimize the impact and potential disruption to TI customers and stakeholders
- Support a timely and effective response, recovery and contingency for interrupted TI business operations, such as design planning, supply chain, manufacturing, sales and, shipping
- Minimizing TI financial and operational impacts that could seriously jeopardize the corporation and brand
- Satisfy TI's business obligations throughout the crisis event
- Communicate effectively in order to provide accurate and consistent information to internal and external stakeholders
- Address TI employee, humanitarian and community concerns where TI operates
- Ensure TI leadership support and expectations for program elements

24 IDENTIFICATION AND TRACEABILITY

TI Products are identified from raw materials through all stages of production and shipment to the customer. The tracking procedure includes:

- Assignment of a unique identifier to each lot or batch of material
- Recording the completion of each process step and the inspection and test status recording of pass/fail quantities
- Identification of key process information as defined in work instructions
- Recording of key process parametric data as defined in work instructions
- Traceability to key raw materials and the production process as needed
- Assignment of a unique tracking STC (Ship Track Code) for every intermediate container (bag, box, reel) is located in TI's standard 2D label.
- Custom marking for Products will need to mutually agreed between the customer and TI

25 PACKING

The packing design for components shipped to customers will be TI's responsibility and conforms to JEDEC-STD-033 for moisture sensitive devices. The packing material has been designed to guard against damage during shipping, stacking and handling. If there are major changes in the packing design TI will communicate appropriately to the customer or distributor through the previously mentioned change management process.

26 SHELF LIFE

TI's standard shelf life for packaged products is two years from the time it was manufactured. There are devices which are specifically packed for extended storage up to five years. TI product shipment is based on Moisture Sensitivity Levels (MSL) and complies with JEDEC-STD-020. Product warranty is measured from the date TI or the TI-authorized distributor delivers the product, not the date of manufacture.

Customers can check product Extended Shelf Life (ESL) capability thru TI's Extended Shelf Life: Part Search tool:

27 LOT COMBINATION

Assembly date codes will not be combined prior to final pack. For Products, four (4) date codes maximum, not more than 52 weeks apart may be combined into one intermediate manufacturing pack (bag/box/reel). 52 weeks must be calculated from Max Age Lot Trace Code minus Min Age Lot Trace Code.

28 CUSTOMER LABELING

Consistent with industry standards TI's provides a human readable and 2D data label attached to every intermediate manufacturing container (bag, box and/or reel) used in the Product identification/tracking and receiving process. Each label will include, as applicable, lot traceability information MSL level, and appropriate regulatory compliance markings.

29 ARCHIVING PERIOD

TI has a comprehensive record retention strategy which must account for more than fifty different categories of record types, with retention periods matrixed against market segments

Storage locations and archival processes also vary by record type and are managed as part of this comprehensive strategy which is in-line with industry standards. All TI record retention periods are subject to change without notification.

30 RESTRICTED CHEMICALS AND MATERIALS (RCM)

TI manages product compliance status through its RCM management program. Materials used in TI finished IC products must go through an approval process that includes: complete substance declarations, supplier compliance statements and applicable 3rd party test

TI requires its suppliers to comply with TI's "Customer Material Specification (Controlled Chemicals and Materials)," which incorporates TI's "Restricted Chemicals and Materials List." Suppliers must certify the presence and concentration of any substances on TI's RCM list above threshold and update their certificates every year. TI's RCM program requires the suppliers use accredited labs to perform testing for 10 European Union Restriction of Hazardous Substances (RoHS) substances and for materials that may possibly contain chlorine or bromine based flame retardants. All other restricted chemicals are verified through material declarations and/or compliance statements from these suppliers.

TI's RCM management program provides data that feeds into the environmental and product stewardship information found at www.ti.com/ecoinfo. Customers can access the latest TI statements regarding material content of Products, including the Product Content database (www.ti.com/productcontent) which allows customers to search by part number to view specific material content information. Proprietary substances or materials will not be disclosed in its material content reports. Any additional questions related to the material content of our Products should be directed to the TI Customer Support Center at www.ti.com/support.

31 CONFLICT MINERALS

TI uses tungsten, tantalum, tin, and gold in most of its Products these minerals are identified as "conflict minerals" in Section 1502 of the Dodd-Frank Wall Street Reform and Consumer Protection Act. TI does not purchase these metals directly from smelters or mines and TI is working with our direct suppliers of these metals to understand their supply chain and determine the origin of these metals. In 2016, TI determined that all semiconductor integrated circuit products were conflict-free. In the absence of federal regulations, TI, as a member of, the Responsible Business Alliance (RBA) has been working with the Responsible Minerals Initiative (RMI) to ensure due diligence is applied to controlling of the sources of these metals. Please see TI's statement on conflict minerals.

32 ENVIRONMENTAL SAFETY AND HEALTH

TI has a strong history of environmental stewardship and works to continuously improve environmental performance and efficiency at its sites worldwide. We make significant investments to operate sustainably, reduce our carbon footprint, better manage waste and air emissions, and reduce water and energy consumption. Our environmental, safety and health (ESH) policy and principles guide our efforts to operate sustainably – from efficient product distribution and employee commuting to maintaining compliance with environmental regulatory requirements. Additional information can be found on the Citizenship and Community page.

It is the responsibility of every TI employee to understand and support TI's ESH policy and principles. All TI employees globally receive ESH training on TI's programs to ensure their safety and health and contribution to environmental stewardship. TI's occupational health and safety management system helps us reduce or eliminate risk that could result in personal injury or illness. TI employees receive additional relevant training and communications based on their role and working environment. Contractors must also comply with TI's ESH standards. TI manufacturing sites worldwide have obtained Occupational Health and Safety Assessment Series (OHSAS) 18001 and International Standardization Organization (ISO) 14001 external certifications.

33 RESPONSIBLE BUSINESS ALLIANCE

TI is a member of the Responsible Business Alliance (RBA, Formerly the Electronic Industry Citizenship Coalition follows the RBA Code of Conduct (Code) see http://www.responsiblebusiness.org/standards/code-of-conduct/

The Code establishes standards to ensure that working conditions in the electronics industry supply chain are safe, that workers are treated with respect and dignity, and that business operations are environmentally responsible and conducted ethically. TI is actively working to implement the code throughout our supply chain.

34 ABBREVIATIONS

AEC: Automotive Electronics Council

AIAG: Automotive International Action Group

APQP: Advanced Product Quality Planning

CODE: EICC Code of Conduct

ECHA: European Chemicals Agency

EICC: Electronic Industry Citizenship Coalition

EU: European Union

FMEA: Failure Mode and Effect Analysis

GQG: General Quality Guidelines

GRR: Gage Repeatability and Reproducibility

ISO: International Standardization Organization

IATF International Automotive Task Force

JEDEC: Joint Electron Devices Engineering Council

NDA: Non-disclosure agreement

MSA: Measurement System Analysis

OHSAS: Occupational Health and Safety Assessment Series

PCN: Product Change Notification

PPAP: Production Part Approval Process

REACH: Registration, Evaluation, Authorization and Restriction of Chemicals

SBL: Standard Statistical Bin Outlier

SPC: Statistical Process Control

SVHC: Substances of Very High Concern

SYL: Statistical Yield Outlier

WW: World Wide

35 RECORD OF CHANGES

Revision	Reason for Change	Paragraphs Modified	Date
0	Initial Release	Initial Release	09/04/2012
1	Important Notice was missing in PDF	Page 12/13 added	11/05/2012
2	- Remove reference to MPA - Corrected “External Laboratories” to “External Calibration Laboratories” - To show TI’s Product Discontinuance Policy - To make reference to TI/eco info and Product content at ti.com for access to RCM documentation	Paragraph 1 Paragraph 6 Paragraph 20 Paragraph 26	01/27/2014

	- To remove the reference of ISO14001 certification by 2012	Paragraph 28	
3	- Removed Chapters from the document - removed capitalization of “customer” - Removed reference to contacting quality or sales rep and link to quality documents - Added language around the scope of customer audits - Added schedule with examples - Replaced commercial grade with non-automotive, removed the reference to tailored enhanced reliability testing - Reworded for clarity - Added examples of TI’s continuous improvement processes - Changed the word “defective” to “nonconforming” - Changed the word “problems” to “issues”, Changed Product Information center to TI’s Sales Support Line - Included how JESD46 defines a major change - Added 2 bullets regarding ship tracking code and customer markings - Added a method for customers to verify ESL parts - Added lot combination paragraph - Added customer labeling paragraph - Added sentence stating retention periods are subject to change without verification	Throughout document Throughout document Paragraph 1 Paragraph 4 Paragraph 7 Paragraph 9 Paragraph 12 Paragraph 15 Paragraph 16 Paragraph 18 Paragraph 19 Paragraph 22 Paragraph 24 Paragraph 25 Paragraph 26 Paragraph 27	07/16/2014
4	- Revised to change Vice President’s signature	Page 1	12/03/2014
5	- Revised to change wording from TS/IS 16949 to IATF 16949 - Updated purchasing and supplier management section - Changed Qualification / Reliability section - Changed section on PPAP - Changed Change Management section to new standards - Rewrite of EH&S	2, 4, 5, 9, 12, 16, 17, 18, 19, 20, 30	06/12/2017
6	- Defined “TI Products” in Scope paragraph - Capitalized “Products” throughout document - Removed reference to Automotive throughout document - Added Interested Parties, cybersecurity and anti-counterfeit paragraphs - Clarified Risk Management section with additional examples - Added reference to the customer return portal in the Customer Return paragraph - Modified RCM paragraph to provide clarity on TI’s restricted chemical process - Changed EICC to RBA Responsible Business Alliance	1, 4, 5, 6, 7, 8, 11, 12,13, 14, 20, 22, 30, 31, 33	

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